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Change Rules the Rails

By DR. C. M. A. STINE, *Vice-President, E. I. du Pont de Nemours & Company, Inc.*

Before the 9th annual dinner of the Wilmington Traffic Club and guests representative of principal transportation interests of the country, at the Hotel du Pont, Wilmington, Delaware, February 11, 1936.

(ABRIDGED FOR VITAL SPEECHES)

IN recent years all forms of transportation, save aviation alone, have seen traffic shrink and revenues decline as a consequence of depressed economic conditions. Happily, these seem now to be passing, but the ills of the railroads have been diagnosed as being of a more enduring nature. Motor trucks and passenger automobiles have been blamed for inroads upon railway revenues that have seriously impaired and, in some instances, wiped out the profit of operation. Air transport is taking a growing toll of a type of business that the railroads alone once had; in addition unfair competition has been charged against the waterways, many of which have benefited by government aid.

From a competition that within the lives of most of us was almost wholly between themselves, our railroads have suddenly been plunged into a whirl of general competition wherein, to the shipper and the traveler, the means of transport are subordinate to the end. Rail supremacy has been challenged, most strongly in the passenger field. I say this has happened suddenly because it has taken place in a little more than a generation. And what should be especially significant in this day, when the only certain thing is the certainty of change, is the fact that the railroads were found vulnerable precisely at the time when they apparently had established absolute invulnerability. When the world laughed at the wheezing and puffing gasoline buggy it was the men at the throttle of the mighty Iron Horse who laughed longest and loudest.

It seemed then they could well afford to laugh. In 1896 there were but four gasoline-driven cars in the country—a Duryea, a Ford, a Haynes and a Benz, the last of German manufacture. They were clumsy and unreliable and easily could be outdistanced by a good horse and carriage. That year the railroads carried almost 100 billion ton-miles of freight, while locomotives were in service that had proven by actual test a speed capacity of 112½ miles per hour. That record speed had been attained in 1893 by the New York Central over a measured mile. Two years later a train of the Pennsylvania maintained a speed of 102 miles per hour for five miles. The fastest of the streamlined trains of today could be paced by those thundering steam-propelled comets of more than forty years ago.

When the first automobile show was held in New York City in 1900, one-third of the space was taken up by electric cars, and steam cars occupied most of what space was left. The number of motor vehicles in the country had increased to 8,000, but not a motor truck had yet been made, paved highways were virtually unknown outside of large cities, Henry Ford was a hired worker for a company that later was to become Cadillac, and General Motors was not yet even dreamed.

If automobile manufacturing in 1900 could be called an industry it is only by reason of its subsequent development and not by its merit then. It was not even certain about its basic power source. Its most optimistic friends looked upon the motor car more as a potential competitor of the bicycle than of the horse—competition with railroads was not even broached.

Yet looking back through the eyes of modern research, the most casual survey of land transportation as it developed during the 19th century reveals facts that well might have caused the railroad executive of the early 1900's to obey his own warning to stop, look and listen. A tremendous railway

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construction and development job, paralleled in no other nation of the world, had been performed between the coming of the first locomotive and that first show of horseless carriages in New York. The forty miles of track of 1830 has been lengthened to 193,000 miles. This vast mileage had been driven by force and skill through wilderness and over desert, the so-called impassible streams and chasms had been bridged, the barriers of a continent had been climbed or pierced by tunnels, and as the century turned, the right-of-ways of the Iron Horse crossed and criss-crossed the nation. They were the arteries through which poured the blood that gave life to an empire.

The glory of this achievement is something that never can be taken from the American railroader. It grows in retrospect, regardless of what sins of omission and commission may otherwise be revealed. Perhaps it pardons the sins, if sins there were. However, while the modern research man is thrilled as he looks back upon the record of railway building and organization, and while his pulse quickens to the romance of heroic deeds done, he also is forced to note a weakness in the railway armor of those days—a weakness, it so happens, that is particularly of interest now, because in the modern railroad's effort to correct this weakness seems to lie the path to railway security and prosperity in the future.

Eight great inventions stand out as milestones of railroad progress during the 19th century—the telegraph, the sleeping car, the automatic block signal system, the air brake, the refrigerator car, the automatic car coupler, the vestibule buffer, and the electric locomotive. Of course, other improvements in track, switches, rolling stock and motive power of a very comprehensive and widely varied sort increased efficiency, speed and transport ability in general, but these eight stand out as major contributions. Lacking any of them, the railway advance would have been seriously retarded.

Rather astonishingly, however, most of the originators of these major innovations upon which railway progress was so vitally dependant, belonged to callings remote from transportation. The land telegraph was not limited in its applications to railroading, but it was on the railroads that it first found its widest use, to an extent that quickly made it an operating necessity. Its inventors were Wheatstone, an English professor of philosophy, and Morse, an American artist. Pullman, inventor of the modern sleeping car with folding berth, was a street contractor in Chicago when he conceived the idea that was to revolutionize rail travel by night. Eli H. Janney, who patented the first automatic car coupler in 1868, was a clerk in a drygoods store. The automatic block signal system, an even more important contribution to railway speed and safety, was originated by Thomas Seavey Hall, a retired textile manufacturer of Massachusetts.

The famous Westinghouse was a youngster of 23 when he invented the airbrake and his only previous experience had been as a worker in his father's carpenter and machine shop. A physician and sanitarium proprietor, Hosea W. Libbey, invented the vestibule buffer that made it possible to eliminate open platforms on passenger trains and to cushion the jolts of starting and stopping. The refrigerator car, introduced about 1871, was largely a development of the meat packing industry. We are prone to think of the electric locomotive as a comparatively recent creation, but the first one was designed in 1847 by Moses G. Farmer. He was a school teacher.

Today, with large-scale research as the motivating force behind the new in industry, we have become habituated to expect each industry to originate and foster its own improvements. Indeed, it seems only logical to look to the telephone expert for the advances in telephony, to the electrical engineer for betterments in lighting and power equipment, to the steel man for finer and stronger steels, and to the automobile builder for better automobiles. It is somewhat difficult to understand, by those of us trained in present-day methods of development, why the great innovations in rail transportation I have mentioned did not come from the transportation field; for that matter why the motor car itself, distinctly a unit of transport, was not conceived and perfected by men with transportation experience and antecedents.

Obviously, something was lacking in the railroad scheme of organization in the 19th Century. During more than seventy years of sensational physical and operating development, there was a lamentable absence of creative thinking. Call the roll of great railroad names—Harriman, Hill, Gould, Vanderbilt, Rea—and at once we think of financiers, organizers, leaders of men, builders of Empire, but not of inventive and scientific geniuses.

Research was the great lack of the railroads, the weakness in their armor. True, they were not alone in this deficiency—it was an almost general one in industry during the 19th Century. The National Research Council finds that the first industrial research laboratory was not formally established until 1888, by the du Pont Company on the banks of the Brandywine just outside of Wilmington, Delaware. Wide recognition of the importance of scientific research in industry did not come until industry was pressed to solve the production problems arising out of the World War.

Although almost a half-century has passed since the founding of that first laboratory by the du Pont Company, although the 20th Century is more than one-third gone and the armistice that ended the World War is almost a generation old; although the number of industrial research laboratories in the United States is now in excess of 1,600, their workers in excess of 35,000, and their total expenditures in excess of 200 millions of dollars annually; although research has built the foundations of whose vast industries such as the telephone, electric, radio and modern chemical industries, and has been the keystone in the success of the automobile and aviation industries; although the whole industrial and scientific worlds have rushed ahead at a breathless pace, thanks to research, the railroads by and large are today still lacking in anything like adequate research facilities. They depend largely on their suppliers for new equipment development, and their own efforts are confined in the main to testing the discoveries of others. This is not research as the term is understood today, a fact that railroad leaders themselves are beginning to keenly appreciate. Almost, may it be said, that, with railroads, scientific research has been the exception; in the automotive industry it has been a mandatory requirement of staying in business. This automotive research has not been limited to improving products—millions have been spent to learn the types of products and services the public wants.

Research has made it possible for the motor car to achieve a development in forty years that easily equals in magnitude the railroad development of 100 years. Moreover, the automotive engineer and designer have made substantial contributions to the marine and air transport fields, while

all three of these agencies have fostered or inspired many of the major changes in rail equipment and power of the past decade. When the first of the already famous streamlined trains went into service on the Burlington in 1934 it was powered by a Diesel-electric engine built by Winton, a subsidiary of General Motors. Its streamlining was a development of aviation. The roller-bearings on which spun its wheels had been made by Timken, an automotive supplier. And the train itself had been built by Edward G. Budd, an automobile body and wheel manufacturer, out of stainless steel developed by metalurgical chemists and given its first wide use in America by Henry Ford.

I am not attempting to indict the railroads. I could as readily and perhaps more eloquently extol their accomplishments. They have made our modern industrial structure possible. But it is weakness, not strength, that causes illness. It is not what the railroads have done but what they have left undone that is the cause of their present plight. If the past were without flaws, if the railroad record were perfect and complete, if every available remedy had been applied and the last resource of human genius had been exhausted, the railroads' plight would be a sad one indeed, and the praises that we might heap upon them would be mere eulogy.

However, since we cannot alter the past out of which has grown the railroads' present situation, it is fortunate for them that the past has not been perfect and that every remedy has not been applied. Railroad men of today may even rejoice over the omission of their predecessors, because omissions may be corrected by commissions. The greater the neglect of research has been by yesterday's railroad, the greater are the possibilities in research for the railroad of today and tomorrow.

Indeed, it is impossible to judge the future of rail transportation from its present aspects. Burdened with obsolete rolling stock in which they have heavy investments, handicapped by restricting laws and regulatory red-tape, by depleted earnings and lack of funds for wide-scale improvements, the railroads have been able to make only a limited use as yet of the newest equipment already available. A modern railroad system as a whole is in large part yet to be built. The steam locomotive of today is essentially the same locomotive in principle that Stephenson hitched to the first practical railroad train in 1829. Standard box cars in use are virtually of the same design as those of seventy-five years ago. We talk of new speeds of trains in motion, but according to the Federal Co-ordinator of Transportation, the average overall speed of freight from consignor to consignee is less than ten miles per hour. The same authority finds that ninety per cent of the average freight car's life is spent in terminals, switching, loading, unloading and around shops.

The only way in which the railroads can maintain their place in transportation is by giving service more efficient than their competitors. The one way to better service lies in better equipment and better methods, and in a more general appreciation of the fact that transportation is a servant of our industrial system, not its master. Railroaders ask what can scientific research do about this? Railroading, they say, is a he-man's job and it can't be taken apart and put together again willy-nilly under a microscope. It is proper that doubt should be raised. Research costs money and the railroads have no money to throw away on what might be profitless experiments. Nobody can guarantee the results of research in advance. However, the records abound with proofs that research *usually* is profitable when properly prosecuted and sympathetically directed. The best answer, therefore, as to what scientific research might do for the railroads is to be found in what it has already done for them and for industry in general.

It so happens that the greater part of my life has been spent in the chemical industry. It is an industry based on scientific research and dedicated to change. And so broad is its field, so all-embracing are its interests, so widely scattered are its achievements and beneficiaries, that it is almost literally true to say that the chemical industry as now constituted is the common laboratory of all other industries. There is scarcely an article that enters into civilized life that is not touched by chemistry at some stage in its course to the consumer. There is scarcely a ton of freight hauled by any transport agency you may name that does not wear somewhere a chemical brand. Indeed, the goods of day-to-day transport and the changes that alter them from year to year might be regarded as the words, sentences and chapters of chemistry's history in the writing. Look into your box cars and freight cars, and into your ships' holds and trucks—look at the motor truck itself—and you will see the concrete evidence of the research worker's place in today's industrial sun.

To attempt to catalogue the changes brought about by chemical research alone, or to estimate the tonnage originated as a result of it, would require the services of a corps of investigators for a year or more. However, the broad outline of chemically-induced change in some of the major industries may be drawn, to indicate what it will of the value of scientific research in general and of its possible value to the railroads in particular.

Chemical research has made possible the automotive industry on its present scale. Not only have its contributions been vital in the manufacture of the motor car itself, but they have been fundamentally important in establishing the oil, rubber and modern highway industries. Without chemical research it is highly doubtful if the mass production of automobiles at prevailing prices would have been possible; without research the motor truck would be little more than an uneconomic curiosity on our roads. Difficulties fully as great if not greater than those facing the railroads stood in the path of the automobile's march. Research was the vanguard that swept them aside.

Take some of the commoner instances:

In 1913 it took six weeks to apply the twenty-two distinct coats of old-style paint and varnish to the automobile body. By 1920, through herculean efforts of management and research, the body-painting job had been cut to one and a half weeks. Then, in 1923, the research chemist produced the first of the nitrocellulose lacquers, and the time was cut to two days. Now, the motor car body can be finished from the raw metal out in a single day, in colors that did not exist for this purpose before, in finishes of a durability once thought unattainable.

Lighter, stronger, rust-resisting metals were needed. The metallurgist and electrochemist have developed more than 10,000 alloys that have gone into every department of industry. It was chiefly the demands of the automobile and the airplane that inspired this research, which in turn revolutionized steel-making and all metal working, and made possible some of the most recent changes in railway rolling-stock. Cars such as Chevrolet, Ford, Plymouth and others

in the lower-price classes would cost five times what they do were it not for the development of high-speed steels. They could not be produced at all in their present designs were only the original carbon steels to be had.

New insulating materials, new pyroxylin and rubber-coated fabrics more serviceable than leather and of infinitely less cost, new materials for upholstery and new dyes, new gaskets and new gears, new glass that will not shatter and new-type storage batteries—chemical research developed them, improved them, made them foolproof and made them cheap. Few of the materials in the modern automobile existed when Selden was granted his famous patent in 1895.

The early tires were expensive, short-lived and subject to constant trouble. Research tackled this problem too, and over a short span of years tire mileage was increased from about 3,000 miles to more than 20,000 miles. The tire repair kit disappeared from the average automobile, prices dropped. Chemical processes made possible the reclamation of more than 200,000 tons of old rubber yearly, and conversion of it to numerous uses other than the original. The recent development of "DuPrene," a man-made product that is even superior to natural rubber in some respects, from such common raw materials as coal, limestone, salt and water, is an epochal contribution of the research chemist to the rubber industry. This new off-spring of chemical research, even at its present price, stands as a definite barrier against any future anti-American rubber monopoly.

Rubber has more than 30,000 uses. The aggregate value of chemical and other research contributions to its production, fabrication and use is incalculable. And the future promises even more, especially in the use of rubber in transportation equipment. Rubber-tired railway trains are now a subject of experiment. Developments are pending that may double and even treble the life of motor-truck tires. The chief parts of the automobile that do not wear with the car throughout its life are rubber parts. This condition the chemist is fast improving, with his objective the car in which no part will wear out until the car is scrapped.

Take petroleum: At first the yield of gasoline from petroleum was pitifully small, more than warranting the dire prophecies of the rapid depletion of our oil supplies. Some crudes produced as little as five barrels of gasoline to the hundred. Chemical and allied research answered with the perfection of the modern cracking process, and the gasoline yields rose sensationally. The same type of research developed the hydrogenation process of cracking, at still higher temperatures and pressures, whereby 104 barrels of gasoline can be obtained from 100 barrels of crude. Research also found a way, if necessary, to manufacture gasoline from coal. And it perfected methods that eliminated the chance and waste in oil prospecting, and uncovered undreamed of supplies of oil yet to be tapped.

Tetra ethyl lead, a product of chemical research, solved the "knocking" problem for all practical purposes and made possible the present-day high-compression motor. Evaporation was retarded by the petroleum chemist, so that now even high-test gasolines may be left in storage for six months as compared to the old limit of two or three weeks. At the same time, the chemist put a check on the tendency of gasoline to form gum, an improvement that permits motors to be run in common practice up to 20,000 miles and more without carbon removal, and in recent tests up to 100,000 miles. The chemist treated lubricating oil and fitted it for gear loads double and quadruple what the untreated oil could carry.

Countless millions of dollars of wastage in the industry has been eliminated through the chemical development of uses for petroleum by-products, which now number many hundreds. These range from an ingredient for making non-freezing dynamite to chemical agents for influencing the ripening of fruits and destroying insect pests on farm crops. Literally, research has made the oil industry.

Until 1900, most of our hard-surface roads were of macadam, but the majority of all roads outside of large cities were of mud. Most of the concrete used in construction was made from natural cement, most of the asphalt used in America came from foreign deposits, mainly in Trinidad. Since then we have hard-surfaced about 300,000 miles of highway and built or rebuilt more than 3,000,000 miles. Portland cement, manufactured by chemical processes, has practically displaced the natural product, and nearly all of the asphalt used in the United States is now manufactured by chemical methods out of petroleum. The modern hard road is a road built upon chemical and engineering research.

What has this meant to the railroads—this establishing of an integrated group of industries that in 35 years has produced in the United States approximately 63 millions of vehicles with an estimated retail value of 55 billions of dollars, which gives employment to 12 per cent of the nation's workers and pays one out of every eight tax dollars, which in a generation has radically altered our entire industrial and social order and put 125 million of us literally on wheels?

Superficially, highway transport has meant only a headache to the railroads, but it has been an inspirational sort of headache. Rail passenger traffic decline due to motor competition began, roughly, in 1921, and it is almost from that year one may date the story of present-day railroad improvement. More has been done to improve the steam locomotive during the past fifteen or twenty years than was done in all the previous years since its invention—more has been done to improve railway equipment in general. The blow struck by the motor-makers hurt, but it also awakened the dozing railway giant.

As late as 1930 Chicago was 36½ hours from Fort Worth by rail; today, it is only 26½ hours. More than eight hours have been cut off the time between Chicago and Miami, ten hours between Chicago and Los Angeles, and it takes almost one whole day less to go now by railroad from Chicago either to San Francisco or to Portland, Oregon. More than 6,000 air-conditioned cars are now in use, and I believe about 1,000 more are under order. They introduce a new note of luxury and comfort in travel.

To enumerate all the railroad changes in process or proposed as an outgrowth of highway and airway competition would necessitate writing the specifications for almost a complete new railroad system. However, two major changes merit particular emphasis, first, the manner in which the railways themselves are growing in appreciation of highway transport, and second, the manner in which the motor industry has utilized railroad facilities and contributed to railroad revenues.

A decade ago, according to "Railway Age," only 1,600 motor trucks were operated by all the railroads of the country. By 1930, this number had increased to 7,000 trucks. Last year more than 48,000 trucks were owned directly or indirectly by American railroads, and this year, with a new motor vehicle law in force, a sensible further extension of

railroad service to the highways may be expected.

As to automotive transport on the railroads, during that ten-year period just mentioned the railroads hauled 32,000,000 car loads of automobiles, trucks, trailers, parts, accessories, tires, gravel, cement, gasoline and oil, of a total revenue value to them in excess of four and a quarter billions of dollars. Freight originated by and because of the automobile industry today represents about thirteen per cent of the total tonnage the railroads carry.

Take lumber, perhaps our oldest industry. Based on a raw material that is an uncultivated product of nature, few industries seem further removed from chemical research than this one. Yet, since the first wooden tie was spiked into place and the first wooden carriage rolled over iron rails, no industry has seen greater chemical changes, or offers a more illuminating lesson for railway study. As much or more attention is being given today to the chemistry of wood than is being given to the chemistry of metals. Literally, wood to the chemist has become more valuable than gold.

It is almost inconceivable in this day when paper is so plentiful even paupers can waste it, that within the memory of a man less than seventy years old it was a luxury. During the Civil War and earlier, newspapers were so rare that people read them in groups at the post office and corner store. Today, a thousand tons of newsprint is used in the printing of a single Sunday edition of a great New York newspaper. Paper towels are in every public washroom, and the cheapest item of food or merchandise is sold in a paper container. We publish as many books in a year as we have people and a far greater number of pamphlets. We not only produce, but use ten million tons of paper each year, or as much as all the rest of the world combined. And almost two-thirds of this paper is made from chemically-treated wood-pulp supplied by the forests.

The rise of paper has been up steps built by the research chemist—first, the development of the soda process for the reduction of wood to pulp; second, development of the sulphate process for the same purpose; and third, the more recent discovery of the Kraft process. The soda and sulphite processes made paper cheap and plentiful, the Kraft process made it possible to make cheap paper strong. Out of the latter discovery has grown an enormous expansion of the paper board branch of the industry, which, through chemical conversion of wood and of cheap wastes is challenging wood in its natural form in building construction and elsewhere.

The corrugated paper box, seen wherever merchandise is handled, gets its strength from its tough outer paper lining made by the Kraft process. The new strong cheap papers have displaced fabric bags in shipping cement, they have routed the barrel and bin from the retail store. Kindred chemical research has produced wall board, plaster board, gypsum board, and other insulating boards that displace lath and plaster and add greatly to the comfort and efficiency of the modern home. Wrappings and paper board now constitute more than half of the total tonnage of the paper industry, and use of composition boards in building is only in the infancy of its growth.

I have given the average production of the paper industry at ten millions tons. However, this is but a fraction of the aggregate tonnage the industry contributes to train, truck and water carriers. For every million tons of finished goods that move out from the mills, probably a million and a half tons of raw materials must be moved in. Wood pulp tonnage alone exceeds six million tons a year, or almost 340,000 carloads.

Wood is more than wood to the chemist. It is cellulose, and veritably cellulose is a magic material. It is the fibre that forms the cell wall of all plants, but, practically, wood and cotton are its chief sources of supply to the modern chemist. In the form of cellulose and its derivatives, wood and its running mate, cotton, nowadays invade a thousand and one seemingly remote fields in a variety of forms that is almost infinite.

Rayon, the world production of which exceeded a billion pounds in 1935, and which is now of a fineness that is setting standards for silk, is a blood child of forest and cotton field. One-half of the production of women's street and dress shoes, and a growing percentage of men's shoes are today neither sewed, nailed nor pegged—soles are sealed to the uppers with a cellulose cement that is revolutionizing shoe manufacture. Shoe buckles, eyelets, lace tips, and the scuffless pyroxylin coating on women's high heels, all may be traced back through the labyrinth of chemical research to some lumber camp or cotton patch. The safety glass in your automobile, the barrel of the fountain pen in your pocket, the buttons on your coat, the bindings of the books your boy brings home from school, the washable window shades in your home, the toiletware on your wife's dressing table, the upholstery fabric on which you sit in the theater and the motion picture film that you watch —not only these but literally hundreds of other articles in daily use are the chemically transformed descendants of wood or cotton.

Wood itself is being changed by chemical research. Wood preserving, which got its start with railroad ties, is being extended to most wood uses where permanency is desired in construction. The aim is rot-proof, termite-proof, and practically fire-proof lumber, and it is being predicted in the industry that within the next generation use of such lumber will be general in building. The lumber industry, faced by a new competition on all sides, is fighting change with change.

I have mentioned nitrocellulose lacquers—they burst like a bomb over a sleeping paint industry only a dozen years ago. Since then, from a rule-of-thumb business governed largely by traditions, the paint industry has become a vast laboratory of scientific study and inquiry. Glyptal enamel, for which the paint chemist goes half-way around the globe for one vital ingredient, has followed the lacquers as a second revolutionary change in finishes. Dozens of new materials, man-made in the laboratory by chemists, are replacing natural materials in paints that were old when Egypt was still young. Paint proving-grounds dot the country, at which literally thousands of finishes are under test year in and year out under all conditions of exposure. For this awakening, all credit is due to research spurred into action by the needs of transportation.

Rayon, the first man-made textile fibre, was the shot that started what has become a race for research laurels in the textile industry. The whole industry today seeths with change. Shower-proof and soil-resistant fabrics, fabrics that will not wrinkle and lose shape in wear, starchless collars for men that keep their shape after washing, fire-retardant curtains and hangings for the home, moth-proof fabrics and rugs, and that dream of the chemist, synthetic wool, are changes already in the commercial stage or in the course of feverish development. New cleansing agents, which a leading soap

manufacturer hails as "the successor to soap," a product that has undergone no fundamental change in centuries, have been developed by chemists and are being so successfully used that the question of soap's future is being raised.

It is almost unnecessary to mention the part research has played in establishing the electrical, radio and aviation industries. To each, chemistry has contributed most substantially. Electrical insulation today is virtually all of synthetic chemically-compounded materials. The electric lamp is an electrochemical development. Aviation's sensational rise in twenty-five years is one of the research triumphs of the age.

Perhaps more than any one material, metallic aluminum has made possible this progress in the air. Isolation of aluminum by Hall, a student chemist, in 1888 and since then the entire development of this light, rust-resisting metal and its alloys has been wholly an achievement of research. Aluminum, if it was to be had, was quoted at $545 a pound just before the Civil War. In 1879, an American purchased a pair of opera glasses in Paris and the jeweler offered an aluminum or platinum setting at about the same price. The purchaser took aluminum, and lived to see aluminum used for pots in his kitchen and sold in 5-and-10-cents stores. During the past fifteen years, more than 1,500,000 tons of primary and secondary aluminum metal has been consumed in the United States. Transportation is aluminum's biggest customer today, about thirty-eight per cent of the total produced going into automobiles, airplanes, dirigibles, trains, boats and trucks.

Until safe refrigerants could be found, mechanical refrigeration and air conditioning were impractical for general use. Chemical research developed the refrigerants, and a grand total of about 10,000,000 household mechanical refrigerators have since been turned out by the industry. This type of refrigeration is now being made available for motor trucks; aviation is experimenting with it. More than one-half of the air-conditioning units ordered for railroad passenger service last year employed the new safe chemical refrigerants.

The chemical industry itself has undergone what is little short of a revolution since the World War. Prior to that time chemical research in America was largely inorganic. A mere handful of workers—528 persons—made up our total employment in the production of coal tar chemicals.

Since then about 300 millions of dollars have been invested in chemical buildings and equipment by our colleges and schools alone. Only seventy-one doctorates in chemistry were conferred in 1914, as compared to 503 in 1934, or one-third of all doctorates granted. The number of chemistry graduates now exceeds 3,000 yearly, the total of chemists listed by the census has risen from 14,000 to over 30,000. As against the 528 workers in coal tar chemicals in 1914, we now have 11,000. And from the laboratories of the industry have emerged more than 200,000 products entirely new to man, of which the utilization of only a few have revolutionized the methods and products of more than a score of industries, put us in new-type clothing and homes, transformed our daily habits, changed prices, reordered vocations, and established America in the forefront of scientific advance, fortified it against war and saved billions in money.

Do not misunderstand me. Scientific research is not a panacea for all railroad ills, but it is the best antidote of which I know for the sting of competition and change—and unquestionably today change rules the rails, as it rules all industry and all of us as individuals. The railroads have applied research only with measured frugality in the past, but, unless I misread the signs, they will be pressed to the utmost limit of their means in this respect in the future.

In this research the railroads will do well to look not only to improvements of equipment and methods but also to trends and possibly impending changes. Coal bulks large in railroad tonnage today, but there is every possibility that tomorrow it may be piped from the mines to users, in liquid or gaseous form, to the end that we may reduce the enormous waste and nuisance that now results from burning it raw as fuel. Oil companies own and operate 110,000 miles of petroleum and gasoline pipe lines, through which moves in a year the equivalent of 150 million tons of freight lost forever to the rails. This is transportation by the most efficient and most economical known means, and coal may some day turn to it. Hydrogen, added to coal by chemical means, transforms solid coal into a liquid fuel like oil. At any rate, it might not be amiss for railroaders to carefully study all such possibilities.

There is much surplus railroad trackage, a great deal of it because of duplication. The possibilities of converting this right of way into high speed toll highways for truck and bus movements might bear more than casual study. By no means has the last word been said in highway planning and structural materials. The number of accidents upon our highways, due to faulty or careless operation of motor vehicles, or to the inexcusable mingling of a great volume of motor-borne freight and passenger traffic, carries its own ghastly "Stop, Look and Listen" to the thoughtful. The need is clearly indicated for the provision of highway facilities which will, at least in some degree, take away from the motor vehicle operator the power to murder and maim because of his own inefficiency or selfish carelessness.

Then too, the changing needs of the varied types of shippers constitute a widely ramified problem for intensive and continuous research. Goods move today where they may move most cheaply, most safely, and most expeditiously, and the railroader, as the expert in transport, might well be the first to suggest better and more economical shipping methods to the shipper.

In conclusion, I am cognizant of and keenly sympathetic to the fact that small blame, if any, for the current difficulties of the railroads may be charged to the men who are operating them today. On the contrary, they deserve commendation. Beset, first by politically inspired control, next by a disorganizing wartime operation, and finally by an unprecedented depression of business, our rail operators have been struggling valiantly against odds such as have confronted few other groups in industry. Competition and change have been but two of their important, though critically important, problems.

There is much evidence that the rails are facing their problems and, what is more, solving some of them. Knowing many of these men personally, I am quite sure that this generation of railroad men will solve many others. The railroads are, and must continue in an increasing degree to be, the backbone of a smoothly functioning, integrated transportation system, involving motor-driven highway-borne traffic, water-borne craft, pipe-lines, airplanes—all together, I confidently believe, improved in efficiency, and safety, and with costs lowered, through the enhanced application of scientific research.

A National Agricultural Program

By WHEELER McMILLEN, *Editor, The Country Home.*

Before the Institute of Rural Economics, Rutgers University, New Brunswick, New Jersey, February 24, 1936.

THE United States does not have a national agricultural policy. Instead of an aggressive policy directed to one purposeful end, we have a disarray of conflicting projects.

The Adjustment Administration seeks restriction of acreage and production; the Department of the Interior fosters reclamation projects for their expansion.

The Adjustment Administration undertakes to subsidize reduction of the volume of American production, and the Post Office Department subsidizes ships which bring competitive imports into the domestic market.

With one arm the Department of Agriculture ably fosters efficiency in production, and with another arm urges farmers to lower one of the essential factors in efficiency, volume of output.

Congress enacts tariff legislation for the production of domestic markets, and the State Department negotiates reciprocity agreements which provide for admission of competitive farm products.

These are but specimens of the inharmonious medley of antithetical elements that characterize governmental action affecting farmers.

During the nineteenth century, the United States did have an agricultural policy of a sort fairly well adapted to its time. This was a policy of unrestricted expansion of production in all directions. During the twentieth century so far, through Republican and Democratic administrations, Uncle Sam has displayed a remarkable facility for leaping nimbly upon his farm horse and galloping furiously away in all directions.

The present chaotic mixture of cross-purposes could readily enough be replaced by a policy that would be resolutely constructive. The time is ripe to chart a comprehensive and direct national agricultural policy that will carry agriculture in a permanently upward direction and, with it, the entire economy of the nation.

The outlines of such a policy can be stated with reasonable simplicity.

1. American farm producers should be permitted to enjoy exclusive access to all the American markets they can equip themselves to supply.

2. By aggressive measures, every effort should be put forth to enable American producers to include in their output all products that can be developed profitably on American soil.

3. Through two-way trade agreements, outlets should be made secure for the spare portions of those crops that ordinarily are required for foreign consumption.

4. Vigorous measures should be followed for expanding the proportion of agricultural production which can be consumed for other than food uses.

5. Conservation and revitalization of the soil should be fostered.

6. The varied resources of science should be utilized continuously and to the limit wherever they can be applied to reduce production costs, improve quality, augment output, increase consumption, or add new crops.

7. All measures which tend to conflict with these objectives should be discontinued.

Let government aggressively and consistently pursue a policy of conserving domestic markets for our own farmers, of enabling farmers to supply more of America's food and industrial needs, of opening foreign outlets on a practical bookkeeping basis, and of far more vigorous utilization of science—let government hew to those lines, and agriculture may be expected to right itself. With the consequent new crops and markets available, farmers will have profitable occupations for the acres that have produced troublesome surpluses in excess of demand. The increased physical volume of new home-grown wealth will employ men not only in agriculture, but in transportation, processing and distribution. The additional farm income thus derived will be so spent as to make new jobs throughout the national economy. The resultant better balanced agriculture will bring a better balanced national economic structure.

Our problem is not primarily agricultural. We confront a situation that is essentially national. The sore spot is unemployment, which is almost entirely an urban phenomenon. The concept that reduction of unemployment awaits the further enlargement of agricultural income is very clear, once one pauses to examine the full picture.

Consider the inherent solidity of the agricultural industry. In the light of certain facts it is almost spectacular.

Even after a decade and a half of income disadvantage 60 per cent of the total number of farms remains entirely clear of mortgage obligations. In the most troublous period only about 8 per cent failed to make mortgage and interest payments.

Agriculture's equity in its land and buildings is 75 per cent. The urban real estate owners' equity averages only 43 per cent; public utility stockholders' equity in land and equipment averages only 45 per cent, and the railway stockholders' equity in land and equipment averages only 51 per cent, as against agriculture's 75 per cent.

A recent careful study revealed that the average nonfarm family holds property valued at $8,709. The average farm family holds property valued at $9,668, a difference of nearly a thousand dollars in favor of the farm family's worth.

These facts lead to the obvious conclusion that additions to agriculture's income will rapidly flow into the channels of manufacture and trade. Only a small portion will be consumed in meeting back debts, taxes and interest. When one also considers the larger consuming power of the farm family over the city family, it becomes additionally apparent that the improvement of farm income is the shortest route to breaking up the millstone of unemployment. Indeed, business reports last year from the automobile and other industries traced their increased employment almost exclusively to the enlargement of farm purchasing power. This

revival of business resulted from a rise above the low point of little more than two billion dollars. When we succeed in pushing farm income up to its former figure of around twelve billion dollars or a little above that, there will be no question about the widespread restoration of urban employment and urban buying power.

We cannot, however, expect to restore former levels of farm income without an aggressive and consistent policy that recognizes changed national and international conditions.

Our occupation is primarily to furnish foodstuffs for the people of the United States. Feeding our fellow citizens has always been our main job. Probably it always will be our main job.

We have had a secondary market, one of fluctuating importance, in the business of supplying foodstuffs for people who live in other countries.

Unfortunately, neither of these markets—the domestic nor the foreign food consumer—has in recent years demanded enough of our output to assure a prosperous agriculture.

None of us can look into the immediate future and see any promising signs that other countries will resume their former volume of purchases of American farm products. We may as well face the fact that as large scale outlets those markets are matters of history—by no means totally lost, but of severely reduced importance.

The domestic market for the products of our farms is another story. If employment is restored and our cities again become reasonably prosperous, we can expect food consumption to increase somewhat. Apparently reliable figures indicate that if every American citizen had three square meals a day of properly balanced and adequate foods we would have to increase our present acreage of foodstuffs in order to supply the United States alone.

That happy condition, however, does not prevail. We still have probably ten millon unemployed Americans. We do not have the state of prosperity and of education which would make possible consumption within the United States of the maximum output of high quality agricultural products.

Yet we have so increased our efficiency in production that agriculture could feed the United States with one hand, and have the other hand free to engage in some other job. For some ten years I have insisted that a permanent prosperity for agriculture is bound to depend upon finding steady and substantial employment for agriculture's other hand, the hand that is no longer required to grow food either for Americans or for foreigners. I have therefore advocated that it should be a part of a national policy to seek, at every corner and turn, new industrial outlets for our agricultural energies.

The argument need not be repeated at length before this audience. We have the well-known fact that the consumption of food can be expanded very little in quantity; the human stomach is inelastic. The rate of increase in our population is declining, so that the number of stomachs is not growing at the former rate. If we are going to employ to the fullest the potential energies of farm lands and farm people, and make agriculture attractive to farm youth, we have got to have factory markets. We have a far better chance of getting factory markets at home than of winning back our exports abroad.

May I illustrate with a few concrete examples our progress toward new employments for acres and for farmers—as well as for urban workers? In Chicago the other day was opened the fourth soy bean processing plant for that city. None existed there ten years ago. The soy bean crop, hardly known twenty-five years ago, now exceeds rye in acreage. Its market is primarily industrial. Soy bean oil goes into paint, lacquers, and other substances. Soy bean proteins have steadily increased as an ingredient in plastics. One automobile manufacturer who uses soy bean oil in his paint job also makes several car parts from soy bean plastic materials and is now installing machines in a five million dollar plant to increase this output. Soy bean casein threatens to surplant imported milk casein as sizing in the paper industries.

Paper itself promises very soon to become an American farm crop. Dr. Charles H. Herty's researches have opened the way for rapid-growing pine produced under cultivation on Southern farms to supplant our $170,000,000 worth of imported wood pulp and news-print. Rayon and other cellulose products from Southern pine will follow in a section which, because of the decline of cotton badly needs new sources of cash. This industry is on the verge of starting.

An enormous new market for farm products awaits the time when power alcohol comes into general use. Ten per cent of anhydrous alcohol, blended with gasoline in each gallon of motor fuel used in the United States, would now require 1,700,000,000 gallons of alcohol annually, providing eventual new occupation for perhaps twenty millions of acres. The superiority of this fuel has already been demonstrated. Now used in twenty-two countries of the world, the present actual demand in the United States is far in excess of the available supply. The alcohol can be produced from low grade corn and a good many other products. Its advocates anticipate, however, that the most productive source will be the easily grown Jerusalem artichoke.

There are those who insist that when our petroleum supplies decline, we shall be able to make gasoline more cheaply by the hydrogenation of coal or other methods than we can manufacture fuel from alcohol. How cheaply we can make anhydrous alcohol, no one yet knows. In the cases of petroleum and coal, we are using up irreplaceable natural resources. All other things being equal, is it not better to depend for at least a part of our fuel supply upon that annually replaceable source, the vegetable products of the land?

I can only refer to our potentialities for increasing American farm production of starch, of flax and other vegetable fibers, of several indispensable vegetable oils, and other products, demanded on a large scale by industries. I can only indicate the opportunities in expanded American production of tung oil, in the widespread utilization of cotton as a road material, and in farm production of materials for insecticides. Experimental, semi-commercial, and in some instances fully commercial activities in numerous of these directions are already well under way.

I do not presume to say that this field contains the answer to all our farm questions, nor that it affords completely immediate answers. I do say that in industrial uses for farm grown raw materials we have an absolutely sound procedure and that its realization is more imminent than most of the world suspects. It must be a part of any well-

considered agricultural program, although politically-minded farm groups have ignored it because it does not sound like a vote-production idea.

Political parties at present incline to the notion that they must offer subsidies to farmers. I have no objection to that notion, provided only that such subsidies are clearly in the national interest. Nor do I insist that agriculture has to be subsidized. If the nation can afford to continue expenditures of this type, it should make certain that an investment return is in prospect.

Anticipating the probable demand for subsidy programs, back in mid-November I offered for discussion a national farm program. I believe it represents a constructive use of subsidies as an investment in the national future and that it is in full conformity to the type of national farm policy I have here advocated. The suggested program provides that definite financial inducements should be offered to farmers for four specific purposes, each fully in the national interest.

Under such a program, federal funds would be used in four ways:

First, for soil improvement payments to farmers who put a larger proportion of their acres into legumes and fertility-restoring crops.

Second, improvement payments would be offered farmers who take the measures which are necessary in their respective areas to prevent further destruction of the soil by erosion.

Third, development payments would be offered farmers who undertake to grow products which the United States must now import from other countries.

Fourth, development payments would be offered for the production of marketable crops to go into industrial consumption rather than into the presently over-supplied food markets.

This program would require no coercion or control. Farmers would simply have the choice of taking advantage of the offers, or of following their usual routines. Prevention of surpluses would be effectuated by the new employment for acreage.

The first question one hears is where will the money come from. Under the amended Adjustment Act thirty per cent of the tariff revenues was diverted for use by the Secretary of Agriculture for purposes in connection with the Act. With this as a precedent, we might take all the tariff revenues, which are about three hundred million dollars a year. They provide not more than about 12 per cent of the government's income. In amount, the three hundred millions contrast with about five hundred and twenty-five millions from processing taxes.

Some might find a certain amount of justice in devoting the proceeds of the tariff to agricultural advantages. In my opinion this device is of no great consequence, however; the money would anyway have to come from the public pocket.

I suppose it can be said that a farmer should not be paid for following the kind of crop program he ought to follow. Nevertheless it has been difficult for many farmers to obtain sufficient immediate cash income from rotations that include the proper proportions of soil-building crops. The United States cannot afford to lose the fertility of its fields.

Precisely the same argument may be advanced in favor of payments to farmers for preventing soil losses by erosion.

These two points are universally accepted as nationally desirable. When we come, however, to the matter of subsidizing domestic production of agricultural products now imported, we step into the midst of a very lively argument. The sincere belief is held by many intelligent people that if we import more of the production of other countries we shall therefore profit by being able to export more American goods. This theory has lately been preached with special vigor. The only weaknesses of the theory are that it is historically out of date; that it is not sound, and its pursuit will inevitably lead the United States to expensive and disastrous consequences.

I am in favor of foreign trade, and in favor of international agreements—to the extent that whenever we accept a specified amount of foreign products we shall be assured of a definite market for a specific and equal quantity of our own products. Upon this basis, of what George Peek calls "good old-fashioned Yankee trading," we can build the kind of foreign commerce that will be profitable under current conditions.

Unless we build our commerce on some such quid-pro-quo basis, we have no assurance of making any exports, regardless of how much and what we import. The history of recent years is evidence of that. Foreign interests have been buying in America, but by no means have their purchases been confined to the products of American farms and factories. They have been buying the factories themselves, and, yes, some of the farms. We find today some seven billions of dollars of foreign capital invested in our productive facilities. Foreigners have bought our stocks and bonds, and are now buying our real estate with money that, according to the theories of the internationalists, is supposed to be buying our goods.

This, I submit, is a dangerous situation. They call sell our securities, as they can buy them, on a minute's notice, precipitating another financial panic. This is about what happened in 1929, when they suddenly sold the securities they had purchased with money we had been foolish enough to lend them.

Some of us think, and I hope some of you will agree, that in the world as we find it in 1936 the time has come when the United States should quit playing the international Santa Claus. In a selfish world, where every nation and every people seek their own welfare and their own safety first, through economic self-sufficiency, we shall be foolish indeed if we fail to take advantage of our own superior position for playing that game. The time has come when citizens should look realistically at the cold facts, and that means the time has come when Americans should think first of Americans.

In that connection, may I ask what country in the world other than the United States, in a period of depression, when great sums must be spent to relieve unemployment, would permit five million unnaturalized alien persons not only to remain within its borders and to compete for the jobs of its own citizens, but would support many of them on relief?

But let's get back to this proposal that we might offer bonuses to farmers who grow crops now imported. The first question is—what crops? The biggest one, and undoubtedly the most controversial, is sugar. I incline to the belief that it would be to our advantage to undertake to grow our own sugar, even if we had to depend entirely upon present crops. There is, however, a new element in this

picture. The Jerusalem artichoke, which I mentioned in connection with power alcohol, yields generously of a sugar called levulose, about 75 per cent sweeter than cane or beet sugar. We make a considerable amount of sugar from corn, its sweetness being somewhat below that of an ordinary sugar. One of the most distinguished of commercial research chemists has told me that if he can have levulose at 4 cents a pound to blend with corn sugar, the United States would no longer need to concern itself with imports of sugar. This is one prospect surely worth exploring.

Sugar, however, is not the only important possibility. We import large quantities of vegetable oils, most of which could be replaced by our own oils. We import pyrethrum, out of which insect sprays are made and which we know can be grown in the United States. There are fibers, drug plants, starches, and other items that come within this category.

During 1935, incidentally, we have imported imposing quantities of certain products about which there is no question of our ability to produce. I refer to wheat, to oats, to rye, to barley, to butter, to pork, and to beef. It is true that the quantities have not been relatively large. It is also true that only a small fraction of an egg needs to be bad. Not a very large percentage of an import is required before the effect is felt upon domestic prices. I think it is entirely possible that if American farmers had had the full benefit of the scarcities of these staple products in 1935 the additional returns to agriculture would have been greater than the returns that can be traced to the restriction of production. I will say without fear of contradiction, that these imports certainly did not help our prices. It might well be a national principle that if when nature gives them an excessive production, farmers are to be penalized in price, they should be permitted to benefit in the fullest measure from Nature's scarcity.

Those who assert that we must import products from other countries that might be grown here, because right now other countries will sell them cheaper, those who argue that we must increase imports in order to export, take a short-sighted view. They are blind to the plain and common fact that, given a chance for experience, American producers always improve their techniques and lower their costs. They ignore the flaming fact that the less the United States has to depend on other nations for any vital necessity, the less is our danger of becoming embroiled in foreign wars. They refuse to recognize the simple fact that a dollar spent in the United States will do, in terms of business turnover, ten times as much for this country as a dollar abroad. They fail to catch the vision of building for the future of American acres, American labor, American business, and American youth. One American with a job is a greater asset to this country that a dozen foreigners with jobs created by our imports. And one American farmer with a decent income will do more to make jobs for American workers than a dozen foreign farmers shipping their products into our cities for our money.

This country can make more money producing soy-bean oil on our farms than it can by buying linseed oil from Argentina. This country can make more money and create more new jobs by growing woodpulp on southeastern farms than it can by sending 170 million dollars a year to Canada and northern Europe. We will do better producing our own vegetable oils on our own farms than we can by buying them from the Orient and Africa. It would be better to find out how to produce sugar on American farms from artichokes and corn and beets than it is to send millions to other countries for it. I maintain that we would do better to find our starch in American crops, on American acres, than to buy it from Germany, Holland and Java.

We will be ahead, even if for a time we do pay a little more for some items. For the all-important considerations, after all, are to rebuild our agriculture, to bring opportunity back to farm youth, to dissolve the incubus of unemployment, and by these means to make prosperity general. We need to spread sound industry and activity in the farm country, instead of piling deeper the economically insecure and politically unstable populations of cities that already are too large. To these ends, should we not insist upon a consistent agricultural policy that will enable us to produce in America the things that we need in America, to grow in the United States the things we use in the United States, to guarantee for American farmers the fullest advantage of American markets?

Then, with science blazing the way, with agriculture and industry side by side building for a balanced future, and with government pursuing sound national and agricultural statesmanship, we may expect to restore for ourselves and construct for our children a heritage that will support our most prized American privileges and institutions—including that of representative government.

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Research and Social Progress

By CHARLES F. KETTERING, *President General Motors Research Corp.*

At the Washington Award Banquet, Palmer House, Chicago, Illinois, February 25, 1936.

(STENOTYPE REPORT)

YOU know we sometimes need to define words in order to get at the meaning—I mean more than the superficial meaning. We sometimes mistake what the word "research" means. There is a great difference between the word "planning" and the word "research." To plan beyond your ability to do may or may not be a right thing, but if the planning is of the right order of thought, while it may not be obtainable at the present time, yet a constructive research upon that subject may, and very likely will, bring the result.

Most people think of scientific research as being something to reduce the man hours required to perform any given task. I do not know how that has gotten into our thinking. All the time we hear the subject of technological development talked about as something that is negative. Only in the last phases of technological development does this question of man hours economics become an important factor, We have forgotten entirely the other important factor—and many times more important—and that is the development of jobs and new industries.

You know, engineers have been blamed very largely for our present depression. I suppose the reason that the large number of people have blamed engineers is because there are so few of the engineers to speak back. However, I do not feel that that is the case, but nevertheless one's feelings mean little unless we have some measuring stick with which to get some concrete idea. We are told by very reliable statistics that there is something like forty billions of dollars idle in our American banks. We are also told that there is something between five and fifteen million of people out of employment. The number out of employment is entirely dependent upon which party you belong to. Nevertheless, there is an unemployment problem and there is a financial unemployment problem. Now, the reason that we have that is because both of those things are ends of the same stick. If we had new products, new projects, new reconstructive type of industry, we would have our money employed and we would also have our people employed.

A great many people think engineering and scientific development has gotten ahead of our social absorption ability. I wish that we would look at it in a different way. A man in very great haste to get to a destination came to a railroad station. The train was due to leave at eleven o'clock, but he found to his great consternation when he had gotten there that it had left at ten o'clock. It is a very unusual thing. He sued the railroad company because he said they had pulled out an hour ahead of time. They were brought to trial, the railroad company testified that they did not pull out ahead of time; that was the train of the day before and they were twenty-three hours late.

I think that may be the reason that we think engineering is ahead—it is a lap behind.

In the development of any new industry, it doesn't come full blown. It doesn't come as a completed entity. In fact, I doubt whether anybody is ever conscious of creating an industry at the time it was started. Certainly I know that Oersted didn't know he was creating an industry when he held an electric wire over a compass needle and found it was deflecting. He had searched for that for a long while. Michael Faraday came a little bit farther and wound a coil. Our own Joseph Henry, in this country, was a contemporary in the development of the magnet. But in that simple thing of winding a coil and bar on a bar of iron the fundamental principle of telegraph was developed, and our Morse, taking that as a clew, succeeded in developing the principles, over a very short distance, of our present telegraph. But then these elementary principles and the enormous communication system that we have today in the handling of the printed telegram represented millions of dollars of expended money, heartaches, hundreds of thousands of hours, disappointments, discouragements and everything else. Between the elementary principle and the finished commercial product comes the great work field in which industry has made its progress.

Alexander Graham Bell, trying to improve the telegraph, trying to facilitate the methods of sending messages, discovered the principle of the telephone, and out of that came another new industry that employs thousands of men, and put much money to work. This industry was developed, nobody thinking at the time that it was started that what Bell had discovered represented the basic principle of the new industry. Out of that and other important developments came the principles of radio and other unthought of, and undreamed of things things only a few years ago.

So, today, as we sit here and discuss engineering relationships of science and industry and social development, we hardly recognize that there was a time that we did not have some of these things. We hardly recognize that today you can send a message around the world in one-seventh of a second, if you have anything to send. We hardly recognize and do not appreciate that while we can send a message to the farthest point of the earth in a fourteenth of a second, it may take years before it gets from the outside of a man's head to the inside.

Discussing this with a scientist I asked him how he accounted for it. He said the only way he could account for it was by the relative densities of material.

I was talking to a young man one day and he said, "I think there ought to be a halt called on scientific and engineering developments, because we have gone faster than we are able to socially absorb." I happened to be sitting at the desk. I said, "Let's make a phony telephone call. Let's take the receiver off of that telephone and tell the operator that you would like to speak to the clerk of one of the great hotels in London and you place it back on the stand. In a few minutes that bell will ring and you can talk to the man overseas. You can tell him anything that you wish, engage a room or any other message that you may have to give. No how much did you have to readjust yourself in

order to speak across the sea over what the readjustment would have been had you called a department in your own institution?"

It is not the things that we have today that are wearing us from the standpoint of social development. It is the imaginary things we think we are going to have that we don't quite understand.

I asked him if he had any trouble absorbing the improvements that have been made in medicine, whether he felt that he socially outrun the improved ability to remove an appendix, how much development he had to do socially, mentally or otherwise to get the benefits of the best surgeons in the world? So, I think it is only foolish for us to say that we are not able to absorb socially the developments that we have. The thing that we need to do is to work out the economics of those things so they can flow infinitely more freely than they do. In other words, we have many things developed today which should have a wider distribution, and I do not know whether it is up to the engineer to work out the economics and the method of distribution of those things or whether that belongs to the so-called economists.

In every industry and in every age we have always wished for things, things that we didn't have. We have had in engineering, as we all know, the idea of perpetual motion. We have had the idea of taking power from the air. We have had the idea of having a machine which, once started would keep running forever with nothing put into it, and with us taking out any amount of power that we want. The idea of perpetual motion is as old as thinking man, but it is only recently that that particular type of thought has been applied to economics.

A great deal of our fantastic thinking is nothing but the same old idea of economic perpetual motion. If it works, it is wonderful; if it doesn't, then we will have to do as we have been doing, work.

The possibilities of a hand to engineers depends entirely upon their ability to think. Because we know so very little basically, we know so very little of the fundamentals of our enginering principles. We sometimes, I believe, fool ourselves by saying that we know a great deal scientifically. We do not know how to operate some of the factors to our benefit. We have been able, especially in the line of sanitation, in medicine, to improve human welfare and living conditions tremendously. We have in many other of the mechancial arts been able to do many things which people want. I think the best way to evaluate those things is to try to turn time backwards; in other words, let's see if we didn't have this or that, what would we do? I happened to be talking to a friend or mine the other day who was making a trip in an automobile from Detroit to Miami, Florida. It was the celebration of the 25th anniversary of a similar trip he had made. Twenty-five years ago there wasn't a single mile of paved road between Detroit and Jacksonville, Florida, to say nothing of how few in Miami. All the pavements we had were in the towns and, as we know now, most of the pavements are in the country.

We have forgotten that in that twenty-five years the enormous development of the motor car as a leader in industry has produced an almost complete change in our method of living. It isn't the automobile from a manufacturing standpoint that is represented by that industry. Some thirty-odd years ago I had a canvass made of the number of people employed in the motor car industry, say, thirty or thirty-five years ago. The best figures I could get were about one thousand people. The best figures that we have today are that there are about 11,000,000 people directly or indirectly being sustained by that industry. Certainly it isn't in the manufacturing of motor cars that that number of people are employed, but that is not the motor car industry. The motor car industry is everything that goes with it. It is the highway, as our representative from the civil engineers has told us. It is the steel from the mechanical engineers. It is the chemists. It is all of the things that go into it. A large percentage of our steel is used in the motor cars. Enormous percentages of our glass, still larger percentages of rubber and an extremely large per cent of our petroleum industry is the motor car industry. So when we are talking about an industry, no one thought when he was making the old one-lung automobile that he was developing not only a fundamental leader in industry, but also was developing an accessory industry for everyone of those that are now existent. You can't tell what an idea is going to be. You can't tell what its future is going to lead to. You can only make the contribution of the principle and if it serves a purpose, then an industry develops. Industry grows like corn. You plant the seed and you wait until development comes. If the industry is small it grows in a short time. If it is a great industry it takes a long time. The great developments of both our electric lighting and our telephone industries came in the second twenty-five years of their existence. And so, with these great industries still incompleted, we haven't any idea what is before us, but we do have this: As long as we recognize that we don't know much about them, as long as we recognize that there is human demand for many things of which you and I cannot think, then we ought to have faith enough in our ability and in our natural disposition to do the thing, to go ahead.

I do not feel that anybody should be discouraged and never have, because out of all these experiences it is impossible for us, even those in industry, to project industrial developments a few years ahead. I have been associated with the motor car industry for many years and yet I have never seen even the best forecaster in the world able to tell what was two years ahead in that highly organized thing. What can we do that we haven't done? People say, "What are the next great industries?" You can't tell what they are because you don't know when an industry is starting. You can't tell what is going to come because as long as some of the factors are not there, it doesn't develop. The radio, with its principles developed far in advance of our present vacuum tubes, became an industry almost overnight. Another interesting thing is that in that technical study made by the amateurs who sat up all night to try to telegraph across the street, you had developed the technicians who made your service men. Radio became an operating facility rapidly because of the ready availability of these trained men who had been the amateurs. They were self-educated. Why did they want to study radio? Because they wanted to go into business? No, they hadn't any idea it was a business. It was something they wanted to do. It was an adventure. It was a pioneering effort. What did they expect to get out of it? They hadn't any idea. It was something that looked like it needed to be done and they wanted to do it.

Now we have, perhaps, in the last few decades, become too expert in bookkeeping. We begin to think of return on capital, and yet every motive of our life is determined not by return on capital. When you buy a dining room table do you try to figure out what the earning on that is going to be, what per cent you get on your invested capital? When you send your boy or girl to school do you try to figure a net return on that? I sometimes think that if we tried to raise human children on the same basis as that of the highly organized bookkeeping system upon which we are trying to raise industrial children, a baby nine months old would have to be earning its living.

The engineer must do one great thing. He must teach his financial supporters how to raise industrial children. Remember that a great many of our adventures came as just the natural flux of picking up this thing or that thing and turning it into a useful tool. But as time has gone on, the technicalities of this development work have become greater. Today, the individual does not count for very much, only insofar as that individual can analyze what the controlling problem is and bring together such groups of technicians as are necessary to solve the particular parts. We are in a transition from the individual as a producer of new industries, to the group. We don't know how to do group work very well.

We have got to get away from the early development of new industries on the basis of profit and loss; the basis of return on capital. We have got to think of it as the development of something in which faith, in which the rightness of the thing, becomes the important factor. We have detailed accounting in industry. Sometimes we have that same accounting applied to research and industrial development. They cannot live under such treatment any more than you can budget your baby's bath or milk bottles.

We must treat research, therefore, as an insurance policy. Whatever we pay for that we must think of on the actuarial basis, that over a given period of time and over a fairly large number of projects enough good will come out of it to make it worth while. We have said that the depression has cost us an enormous amount of money. Nobody knows how much. Billions of dollars we are told, and yet a billion dollars a year would keep five or six hundred research laboratories going full time, provided you could get the men. Of course, we haven't yet enough trained men to run that many laboratories, but if we had and had them running for three or four years, the banks would have no money and there would be no unemployment. We would have "help wanted" on every door of every factory in America. That price would be infinitely less to pay for this industrial development than trying to artificially stimulate one in which the principle, the fundamental principle, is not fully recognized. You can't create unless you know what your objectives are. Simply to put people to work without having any recurring coordination means that when the money is exhausted you haven't anything that will go on its own power. It is up to the engineer to advise and in this respect I think he is to blame because he has not been as active in getting his financial advisors to recognize that development of industry is as important as operation of industry. In commending this point to you, I think we all recognize that building is one of the important things of all industry. Operation is an essential, but the number of people who can be employed in operations is rather small as compared to the builders. You have to take our country by and large today and see where we are. What do we need? What would we like to have? And then sit down and say, "How long would it take us to get that? What is there in this thing that we don't know?

Sometimes a great industry is held back for years because of some simple detail and if we don't recognize that detail large sums of money can be spent and no apparent progress made. When finally that last detail is supplied, the industry snaps into action and we go ahead. Almost every line of development has opportunity. If you go back and analyze our industry, say with the factors that made the motor car industry possible, we find three very important things: One, and perhaps the most important, was the pneumatic tire.

If you will read the history of the development of the pneumatic tire you will read one of the most dramatic things in all industrial development.

Mr. Dunlop didn't develop the tire for motor cars. His son rode to school over a piece of rough pavement on a solid rubber-tired bicycle and he complained about it. His father who was a veterinarian, said, "I think I can fix it." He made a wooden wheel and on the edges of the wheel he tacked a canvas loop. Inside of that he put a rubber tube and with a football pump he pumped it up. That was the first pneumatic tire, conceived not as a scientific invention, but something to please a small boy.

If you read the discussions in the scientific papers of the years in which the pneumatic tire was making its way on racing bicycles, because that was the only use for it—you will find very learned discussions among engineers as to the whys and wherefores, why it wouldn't work and why it would work. No progress was made until a very much unknown bicycle rider defeated the champion and then everybody said, "There must be something to it." In other words, Mr. Dunlop produced a sample, a working sample. I sometimes think we discuss too much and don't make enough samples whereby we can get the thing across. I am a great believer in all the formulas and other things that necessarily are used in engineering, but I feel that the fact is very much better ahead of the formula than behind it.

In other words, we can argue ourselves out without samples of some of the very important things, while if somebody who doesn't know nearly as much about it as we do makes an attempt, we find out that the proportionalities of our formula weren't right. If you go back and trace the history of all industry, you will find that exact thing. Somebody did something that everybody was sure wouldn't work. It wouldn't work under certain conditions but the fellow who succeeded didn't do it under those conditions. He did it under slightly different conditions. Out at the Rosenwald Museum here today we saw the story of the development of power, with a replica of Watt's old engine. It was interesting, but how much of the things that were there could you argue out if somebody hadn't tried the experiment? We must try experiments. I know that it is difficult; I know that to sit down and discuss whether or not this thing will work is very important, but we finally must decide whether we know the thing actually or whether we do not.

So, I am for more experimental work in science. I am for bringing out or trying to convert, if you want to think of it, some of the intangibles of our modern science to see if

we can't spin them into the threads that the engineer can use and weave them into our everyday work.

We are told today by very learned men that the things we do that we think are tangible are not; that they are only a mental concept. Now that may be. We may have to have a certain kind of mind in order to believe that those microphones are immaterial, or that something I say in here is repeated to you through a loud speaker, or that this watch is simply a correlation of mental phenomena. There may be minds that can grasp that thing, but it isn't an engineer's. An engineer has to have something he can hit with a hammer.

If there are some people who can conceive of these things without any material relationship whatever, I glory in their ability, but it doesn't help me a bit. I have got to have a hammer and a nail to put two boards together. I can't wish them together, nor anything else.

We need today to lessen that great gap that has existed and is growing wider and wider every year between the so-called pure science and applied science. We are drifting apart, and we are drifting apart for a very definite reason. The pure, theoretical man doesn't like the hard-boiled attitude that the commercial engineer has to have; therefore, when he proposes some of his schemes and he hasn't a sample, and you try them out and they don't work, he doesn't like that. Therefore, he likes to select those problems which the commercial engineer can't ask him any questions about. And the commercial engineer, because of that thing; because of the experience he has had before, doesn't want to go and ask him any questions. So, between the technical education that we have today and the practical thing, a wide breach has been developed.

We find that the younger trained engineers have been given an enormous amount more of mathematics and mathematical physics than the older ones have. I tried to find out why that is. There is nothing wrong with it at all. There is nothing wrong in the mathematical approach to any problem. The only point I raise is that it is not the only approach. Mathematics is a tool in engineering exactly like a milling machine is in a factory. Because a milling machine may be good doesn't mean that you throw out your shapers and your lathes and your planes. I think we are making the problem of doing simple things very much more difficult by trying to mathematize them than we would if we just did them.

A very great instructor in music once, when someone asked him what the word "technique" in music meant, said that it was playing the simplest passages in the most difficult way.

We have developed a lot of technique in engineering and sometimes we make a very great and very difficult problem out of a simple one. I can't help but think that all of the problems of nature are simple, and I think the difficulties we have are very largely due to our own conception of them. In the last few years there have been some very marvelous books published among which I think I remember one called "This Mysterious Universe" by a great engineering author. It is a wonderful book. It is well worth anybody's reading. I have no objection to the book at all and the contents of it. I only object to the title, which should read "A Mysterious Mind's Concept of a Normal Universe." The universe must be normal or it wouldn't have run along so well for such a long period of time.

Each year we look at our geological or some other kind of a clock and we find out that another forty or fifty million years have been added to it, but it has run right along. It hasn't had any special legislation or anything new at all. It has gone right straight ahead.

I have another book, just a new one, on the dilemmas of modern science. On the first page is mass, is it a particle, or a wave? I don't think that should be a dilemma. I think it is both. It can't be both unless we change our minds, and that is the most difficult thing in the world to change, because if we change our minds we sometimes have to admit that some of the things we said yesterday are not so. I don't think that should hurt anybody at all, because it is just an accident if what you say is so.

So if we would get in our minds that in development we are going ahead—that is one thing you can't stop, because you haven't anything to do. There is nothing you can do to keep the earth from turning around on its axis. There is nothing to do about this peculiar way it has of going around the sun, which makes the seasons. They talk about leveling out production, and that sort of thing. The first thing we ought to do is to straighten out the earth's axis and cut out those seasons. That will help a lot. We can't do much about that. So we have got to take this world just as it is. We are going to have our seasons and that is great for the dressmakers and everybody else, because I don't know what we would do if we didn't have some reason for changing styles. We have got to take the things as they are and we have got to go ahead.

The other interesting thing is that all the rest of your lives are going to be lived in the future, unless you spend too much time wishing you had lived them in the past. Therefore, I would like to make that future just about as nice a place to live in as I can think of. If you don't carry over too much of the old, dirty past there; if you begin to think of a polished, bright and glistening and glorious future and say, "Why is it, it can't be that way?" you can solve those problems, because I think you can make them anything you want.

We have a lot of things that we ought to tear down and throw away. I say we ought to rebuild this country. The first thing you know, the bankers and economist says, "Where are you going to get the money from?" I am going to tell you where you are going to get it. In exactly the same place we got the money to build it this far. We didn't have any to start with. All we did was dig this building out of the ground and put it up here. It didn't have to grow. It has always been here, but it wasn't in this particular shape.

We can take man hours and convert material over into almost anything we want to do. First of all, we get scared about what it is going to cost. The only thing we have of any value in this world at all is the natural resources of the country—with which we didn't have anything to do. They were here long before we got here. We sometimes think we created them.

We have the man hours of intelligent, useful people, and every time you cut out a useful world of intelligent active, skilled people, that is the economic loss. Anything we do to keep materials from being converted into human utilities is an economic loss. And if materials are converted, somebody else does something else. The money is only used as the conveyor to carry it from one point to another. We have been calculating in dollars entirely too much.

The wealth of the nation is not in dollars; it is in useful material, and the positive side of economics is the movement of useful materials through the channels of trade. That must always go ahead of the return flow of money through the counting houses.

It is up to the engineer to do the positive side of the thing. For the last ten or fifteen years, I am afraid the engineers have hob-nobbed too much with the bankers. The engineer is a great person in this respect, to work with the banker on this question of standardization. We had the great standardization idea that if we just got everything made alike, what a wonderful world it would be.

I pictured one time the marvelous day of Utopia when every engineer would have standardized everything he could think of. There was going to be a great celebration. Down the main street of the great city of Utopia we were going to have a parade, like the Mardi Gras. At the end of it we had this beautiful arch of accomplishment called "Standardization," and the band played and the floats went down, and the crowds cheered. We had arrived. But as we marched through the arch, if we had turned around and taken a look back at the other side of it, the side we forgot, we would have found that nature had slipped another motto on there that we didn't think of: "This is the land of stagnation, cut-throat price competition and depression." That is where standardization will always lead you in the last analysis.

I have no objection to standardizing the nails that go into my shoes or the buttons on my coat, but I do object to standardizing the style. If I want a coat different, with different kinds of buttons on, I want to get it. We have got them on here because of habit.

There is no more use for those buttons on my sleeve than there is for a rabbit having three ears. And yet custom and style says they go there. In fact if you took them off you wouldn't recognize it. They were put on there for a very useful purpose at one time. Our monks used to eat soup and their long flowing cuffs got in the soup and they put buttons on there and buttoned them up to keep them out of the soup. We have economies on the amount of cloth that goes in the sleeve, but we still leave the buttons. So all we need to do is go back and survey where we came from. Remember research hasn't anything to do with throwing away what is old. Only going back and analyzing whether the old thing may not be entirely revived in its utility by the introduction of some new things.

We sometimes think that time has not contributed very much. A very good friend of mine, who is the president of a university, brought over to this country last fall a great pharmacist from England. He gave five lectures before his medical school. He told this interesting story. He said that for twenty-five years they had a constant research on the so-called medicinal plants of North Africa, but, he said: "After twenty-five years we have not yet found one thing about those plants of North Africa that we didn't already know about them." They had by long years of cut and try developed the very things that scientific research proved. So you need to go back and find out why we do it that way. Why did we do it that way? There is a reason for it. Sometimes we can leave out one thing that we have to do because we haven't this piece of knowledge, and the whole thing will advance. So research, so far as engineering is concerned, is to go back and study why did we do it that way and can we improve it? The other thing is to cut loose our imagination and do a little wishing.

What are same of the things we would like to have? Why can't we have them? Research is not a thing that goes with a laboratory. It is purely a principle and anybody can apply it. It is simply to try to find out if you are satisfied with what you have got, where you are and what you are doing. Write down ten things that you don't like about your business, about yourself, or the things you are doing or working with as your problems. You may not be able to solve the number one, because it may be a very difficult thing, but you will be able to pick out one of them, just like you put the word in the cross-word puzzle. Finally after a period of time you will be surprised to find out how these things break down if you persistently work at them. In other words, research is simply trying to step farther ahead to try to find out, as I say, what you are going to do when you can't keep on doing what you are doing now. That doesn't need to be in a laboratory. It doesn't have to have a chemical balance. It doesn't have to have a burette, a pipette or anything of the kind. Time is going to move on, and time is going to bring to us new things and new facilities, if we have open minds; if we know our locality, if we know not locality in the sense of geography, but if we know where our industry lies with relationship with things that may exist.

One gentleman was showing me some pictures of a great electric lighting unit, with small net units of reciprocating units, belts and so forth. It looked like a forest. That was the predecessor of the steam turbine. The very presence of that was an indication it couldn't continue and you couldn't develop that way. Consequently that is an indication that the thing couldn't be wrong. So we have around us today many things which we dislike. They are the indications. They are the go-ahead signals for work to be done. I never was any more confident that this country can go ahead and develop at any time, even in the most prosperous times, than I am now.

I think the next ten years is going to see a complete renaissance in engineering and scientific development. It is all ahead of us. Every period in time has always had somebody say: "I don't see what new there is to be done." Go out and look. Take any book that gives you the history of industry, and tear out half of the book; read up to that, and they will say we have finished. If we can take out the bugaboo of "your world is finished," and put instead of that "the world is begun," we have a marvelous place to live and a marvelous future ahead of us.

Science and the Press

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Before the Georgia Press Institute of the Georgia Press Association and the Henry W. Grady School of Journalism of the University of Georgia, Athens, Georgia, February 19, 1936.

(CONDENSED BY THE AUTHOR FOR VITAL SPEECHES)

IT IS an encouraging sign that science is today treated as a subject of popular interest. There was a time when the smart thing to do was to look upon science as incomprehensible, mysterious and not truly fit to be understood.

Not so long ago the conventional and accepted method for a newspaper reporter to cover an important and serious science meeting was to take a look at the program with its technical titles, wrinkle his brow as a sign of his misunderstanding aloofness from such things, and then return to his office to write a story that laughed at the scientists for being to him so incomprehensible.

Parthenogenesis, indeed! Who ever heard of that word? Trinitrotoluene. What is it? Proton. Who knows, who cares? said those all too frequent newspaper stories of the past, when it was considered necessary to mark ignorance with attempts to humor.

Those days are gone, let us hope, forever. I have not seen such stories in any newspaper for several years.

Today the press takes science seriously and scientists appreciate and cooperate with the press. These essentially changed attitudes on the part of the press and the world of science are among the most encouraging signs of our times.

The newspapers of our nation can have authoritative and readable accounts of the progress of science delivered to them daily by wire and mail. And editors now realize that there is a real and fundamental circulation-building interest in science among their readers.

No longer is the police or politics or general assignment reporter expected to double in the role of an interpreter of science. Science is a special and respected assignment, even on newspapers of moderate size. Science editors of individual newspapers are not uncommon today.

The press associations and the feature syndicates have found science a field worthy of their cultivation. Every large science meeting has a gallery of science writers, who follow the circuit of science meetings as faithfully and as expertly as the sports writers follow baseball and football teams.

These science writers are translators as well as reporters. Unlike the sports writers, who frequently write in a language that is difficult of comprehension by the person who does not read the sports pages regularly, these science writers must write so that rank and file of the newspaper readers understand and appreciate the achievements of science. They are detechnicalizers. When they hear a scientist talk about malignant growth, they must realize that it may mean cancer. Or that trauma is medical for injury. Or that Folsom man means the early Americans who lived some 10,000 B.C. before the kind of Indians we were brought up upon. Or that benzene and benzine are not the same substances. Or that pyrexia means fever, respiration means breathing, cardiac relates to the heart. Or that isotope is a variety of a chemical element. Or that Pinus palustris means Georgia pine. They must know that G to a psychologist stands for "general intelligence," not God.

One of the great practical virtues of science is that it knows no international boundaries, no creed of religion or politics, no economic pigeon-holes, no racial lines, and no Social Register or Dun and Bradstreet ratings. Science is the most universal of our human activities.

In Delaware, Messrs. du Pont use chemistry to make synthetic rubber, explosives, lacquers and a multitude of other things useful to our civilization. Science is indispensable in this citadel of capitalism, this typical corner of our nation as it appeals to Liberty Leaguers.

In Tennessee, the T.V.A., providing a New Deal yardstick for electric power, uses science and research in its huge dams, power generation plants and industries. Science is indispensable in this planned area, where there is being tried the idea of government-sponsored operation of activities affecting the people as a whole.

In England, with its democratic monarchy, typical of the older forms of government, science is promoted by its industrial associations, its universities and its government laboratories. Britannia's might comes in large measure from the sinews of science.

In Soviet Russia, with its newest of governmental forms, science is elevated nearly to the level of a national religion. Five-year plans, collective farms, arctic conquests, utilization of vast natural resources are dependent upon science's guidance. And the land of the Soviets is pushing science with vigor and support seldom equaled in the other countries.

Mussolini's Italy, circumscribed with sanctions, looks to science to allow her to be more nearly self-contained. Hitler's Germany, despite exiling of the flower of her scientists due to their accident of Jewish blood, turns to science to make sugar from wood and oil from coal, just as she made nitrates for explosives and fertilizer from the air during her World War isolation.

Science serves with equal grace and effectiveness widely varying ideals of international relationships. Those who wish their communities or nations to be self-sufficient and independent of the rest of the world can use science to transmute the national resources available into materials and products that Nature has failed to provide. Science is an ally to the "Buy American" or the "Buy British Goods," or the buy-at-home in any nation compaign.

But science is truly international. A cure for disease developed in Toronto is soon conferring its blessing upon sufferers in New York, Kalamazoo, Tokyo, Vladivostok, London, Berlin and everywhere else that effective medical science exists. There are no tariff walls and no immigration restrictions upon the knowledge and inventions that science

discovers and creates. Scientists are among the international professionals, ranking with actors and waiters in this respect. They talk a language which the public cannot understand without translation, but the formulae, equations and even the special nomenclature of science is often understandable to scientists who do not speak the same every-day language.

The criterion of science, that strict adherence to truth regardless of preconceived notions as to what is right or wrong, is the most universal in the world. Newton's laws of motion are given full acknowledgment, where the Ten Commandments of the Bible are considered heathen doctrine.

Science can be made to shower her benefits upon those of high and lowly birth or economic estate. The pure water supply of a city, the cheap and swift transportation, the cloth that all may wear, the dyes that a king of old could not have had, the medicines that recall from death, the abundant food of our times—these and a thousand other great gifts of science are available for all. If any lack these possibilities of our modern age of science, do not blame science itself, do not ask for moratoria for scientific research, but place the blame where it must rest—upon our negligence in arranging our economic order so that the possibilities of an abundant scientific life are not available to all. Put your mind to the task and discover how the methods of science may be applied to the economics of production and distribution, to the artificialities of money and exchange, and to the vagaries and intricacies of human nature in order that all may live more happily and more effectively.

The cry of the French Revolution that preceded the drop of the guillotine that severed Lavoisier's fertile mind from his shoulders was, "The Republic had no need of savants." History belies that boast of ignorance and prejudiced enthusiasm. Republics, monarchies, dictatorships, soviets, all need science. So do those states and cities, the industrial cartels and the labor unions within them. Excise science from our body social and politic, and we are surely asking that the guillotine be applied to our civilization's progress.

It happens that this year is an anniversary in the life of the institution with which I am connected. Science Service is fifteen years old. Science Service is the outgrowth of cooperation between journalists and scientists. The two joint founders of Science Service—E. W. Scripps, furnishing endowment and journalistic orientation, and W. E. Ritter, furnishing scientific inspiration and securing the cooperation of organized science—are typical of this cooperation between the press and science. Science Service has pioneered and continues to pioneer in the difficult, exacting and sociologically important work of interpreting the discoveries, inventions, achievements and philosophies of science into the language of the man in the street, in order that he may act intelligently in his every-day personal, home, business and civic life.

The direct contact that science makes with the men, women and children of America through the medium of Science Service is large and effective. A fifth of the reading population is reached by the product of Science Service. Over a hundred newspapers, from the Pacific to the Atlantic, are sent news and interpretation of science daily by wire or mail, feature material, photographs, illustrations, and a variety of other material for their news and editorial columns.

Since the early days of radio broadcasting Science Service has utilized that medium of communication with the public, reaching millions by nation-wide chain programs and talks from independent "educational" stations. Magazine articles and books are produced by the staff and are effective channels to the public. The weekly *Science News Letter* has had an interesting growth to a magazine of national influence, proving particularly useful in bringing the latest development of science to the attention of persons in key positions of influence, such as industrialists, teachers, ministers, etc.

The participation of great national organizations of science—the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science—in the control and conduct of Science Service has been an important factor in its growth and conduct. These organizations, together with the journalistic profession and the E. W. Scripps estate, nominate the trustees of Science Service. The Board of Trustees of Science Service reads like a roll of eminent leaders in science and journalism, which it is.

Just as the trustees combine the influence and guidance of the fields of science and the press, so the staff of Science Service is a hybridization of science and the press. But here the merging of the two somewhat diverse fields takes a different form. It is necessary to have scientist and writer in the same person and mind.

Members of the editorial staff of Science Service are scientists-writers, not just writers. Each staff scientist-writer must be competent in both fields, a difficult combination to find. Editorial staff members of Science Service must move in scientific circles on a plane of equality with those whose researches are being reported. They must also be able to enter a busy news room of a great newspaper and work side by side as equals with those who are experts in the gathering and interpretation of news of politics, crime, business, drama, etc.

Science Service product must measure up to two standards—scientific accuracy and journalistic excellence. At first consideration, these may be thought to be at the two poles of our intellectual world. Actually there is no true incompatibility, but a high degree of skill and competence, a ***higher*** degree perhaps than in some other fields of science and journalism, is necessary in order that scientists and editors, as well as the public, are satisfied and derive benefit.

The fifteenth anniversary of Science Service gives incentive to look over the recent past and appraise the progress of science. Let us divide them into fifteen great fields of science:

1. The glory of the heavens! Astronomy is perhaps the oldest of the sciences, yet the past few years have seen astounding expansion of the horizons of man's knowledge of the universe. One giant instrument, the 100-inch mirror telescope on Mt. Wilson, has played a major role. With it astronomers have seen immense depths of time and space. The great aggregation of stars in which our earth and sun are mere flecks of dust, the great galaxy we see as the Milky Way, has lost its major position in the universe. There are thousands upon thousands of other galaxies of stars, and in these spiral nebulae there are millions of stars greater than our sun. The great 200-inch telescope now building will dig even deeper into space—space that was beyond the com-

prehension of astronomers a few decades ago. In our own part of the universe we know so much more about the stars and their antics. Last year we all had the opportunity of seeing an unusual "new star," Nova Herculis, that flashed to easy visibility and reminded us that immense heavenly catastrophies are possible. The ninth and outermost planet of the solar system, little Pluto, actually about the size of our moon, was discovered in 1930, as the result of years of computations and study. Hope for life on other planets than the earth faded when deadly methane and ammonia were found in the atmosphere of giant planets, Jupiter and Saturn, while immense quantities of carbon dioxide were detected on Venus.

2. Mathematics, combined with the physics of the universe and the atom, has also opened great vistas of intellectual and practical importance. Much of this dates from Albert Einstein. Scientists were not convinced a decade and a half ago that the kind of new physical world described by the theories of relativity really existed. The confirmations of Einstein's verifiable predictions of observable effects convinced them in a spectacular manner. Space and time were explored through vistas open by mental effort just as effectively as with the large telescopes. The new theories of the submicroscopic world, known as quantum theory and quantum mechanics, also owe much to Einstein and other names, such as Planck, Bohr, Heisenberg, de Broglie, Dirac, are also linked with this progress. The great problem for the future is the linking of the universe, as described by relativity, with the world of the atom described by quantum mechanics and reconciling both with the so-called "classic" or everyday physical world.

3. The conquest of matter has progressed with rapidity in the last fifteen years. X-rays have explored solids and allowed the determination of the arrangement of those united of substances and elements, called molecules and atoms. Startling was the idea that there could be variety of the then-possible 92 chemical elements, matter's bricks that make up everything. These isotopes, as they are called, are sort of twins, triplets, quadruplets, quintuplets and even higher multiples among the elements. Most famous was the discovery in 1931 of heavy hydrogen, just twice the weight of ordinary hydrogen of water. Triple-weight hydrogen was found in 1934. Transmutation was the dream of the ancients; modern scientists have achieved it. It is now an everyday occurrence to change one element into another by high-voltage bombardment. Even the spectacular early transmutations, about fifteen years ago, pale before the artificial creation of new elements that are radio-active, such elements as radium sodium that may have application in treatment of cancer. Unsuspected a few years ago are the fundamental particles of matter, the neutron and the positron, discovered in 1932 and now considered as important as the electron and proton. Extraordinary was the manufacture last year of element 93, heavier than any element that previously it was believed could exist.

4. In the general field of physics, of which conquest of matter and atomic chemistry might be considered a part, the outstanding recent burst of research concerns the cosmic rays. Incessantly our bodies and everything else on earth is bombed with these penetrating messages from outer space. The names of Dr. Robert A. Millikan and Dr. Arthur Compton, both Nobelists, are associated with the world-wide researches of the past decade into the nature and significance of cosmic rays. Certain it is that they come from the depths of the universe, and it is probable that, just as they revealed the positron, they will be useful tools in other investigation of the physical world. New records for cold have been set in recent years, not in blizzards or near the North and South Poles, but in low-temperature laboratories. There is a point on science's scale of temperatures 273 degrees below zero Centigrade, which is absolute zero. It is a point that cannot actually be reached, and there all motion of matter ceases. But experiments in 1933 came within a fraction of a degree of attaining this impossible.

5. Chemistry is one of the most powerful and fruitful handmaidens to industry. Since the World War, America has become a center of world chemistry. Substances for which we were previously dependent upon Europe, particularly Germany, are now American-made. And new creations of the chemist's test tubes, beakers and vats are appearing constantly as the result of pure and applied chemical research. Even the riches of the sea are being tapped, and bromine, needed in industry, is extracted from sea water. Sugar can be made from wood, if need be. And liquid fuel of all sorts, for automobiles and other purposes, can be made from coal, banishing the fear of the shortage of gasoline when our petroleum wells run dry in future years. Hydrogenation applied to petroleum has the ability of making one kind of oil into another. In a world that has few unexplored geographical areas we are finding new raw materials for industry upon the old, familiar farms to which we have heretofore looked for food.

6. The conquest of the air, begun in earlier years, came to an extraordinary fruition in the years since 1921. Across oceans, around the world, to the poles, airplanes and airships have blazed new trails of exploration and for commerce. Airlines took a regular place alongside railroads, steamship lines and bus services. Aerodynamically and from an engineering standpoint the airplane made such strides that craft just a few years old were hopelessly obsolete. Much of the striking improvement in airplanes is due to group researches of a great engineering laboratory of the U. S. Government, the Langley Aeronautical Laboratories of the National Advisory Committee for Aeronautics. Reduction of air resistance of engines and fairing to the air other portions of planes added miles to speed without use of more gasoline. Flaps and other devices on airplane wings gave more control and flexibility. Blind flying became possible and a routine, and the autogiro arose as a new breed of aircraft. The stratosphere was conquered by special balloons and rockets began to explore the upper reaches of the atmosphere, with the hope of eventually travelling in outer space.

7. The engineer has built bigger and better. Giant bridges spanned rivers. George Washington Bridge over the Hudson at New York was built, for instance, and San Francisco on its peninsula began to have giant bridge-links fashioned for it, one across the Golden Gate and another across the bay. Boulder Dam arose as an engineering triumph of our age, and the Grand Coulee dam, as massive in some aspects, was begun. The Empire State Building in New York City captured laurels for the highest structure man has reared. Giant ships, the S. S. Normandie and the S. S. Queen Mary, were launched.

8. Invention is one of the great American sports. The

record of patents granted is one index of American progress. In another sense, invention is applied science, particularly applied physics. The recent years have seen an extraordinary development of new progress in communication. Out of fundamental research in optics, electricity, sound and photography, there have come radio, sound motion pictures, photographs by wire and radio, television, and motion pictures in color. These great achievements are peculiarly the result of basic investigation, most of it without having as an objective some practical end. The talkies were forced on Hollywood by the developments made by scientists expert in electrical communication.

9. Now that there are no large blank spaces on the world map, it might be thought that exploration must come to an end. Antarctica still hides a few secrets that the recent airplane forays have not been able to discover, but otherwise the geography of the land surface of the earth is fairly well known. The sea covers a major part of the globe and for this reason echo sounding of the ocean depths is a great aid to mapping the mountains and valleys of the sea as an aid to navigation and geological knowledge. Mother Earth has been self-conscious of her age and would not give an easy answer. But the fact that radioactive substances decay at a known rate into lead have allowed the chemist to help the geologist estimate how old is the earth. The answer is about 2,000,000,000 years.

10. Important in every-day life is the weather and the weather forecast is perhaps the most popular daily feature in our newspapers. Important steps have been taken to improve it, efficient and reliable though it has been for many years. Meteorologists have been giving attention to a way of looking at the weather in the making that is called "air mass analysis". One improvement that has been helpful to the weathermen is the fact that airplanes at many points throughout the nation go aloft and observe the weather at various levels above the earth at the same time that the ordinary weather observations are made at the surface. Weather predictions for a long time in advance are still in the future, but there has been keen interest in the possible effect of variations in the sun's radiation upon the weather here on earth.

11. Science's investigations of life processes have brought important results in recent years. Striking has been the growing of portions of the animal organism outside the body supplied by artificial hearts and other mechanical substitutes for the living body. The mystery of how our mental and physical characteristics are passed on from one generation to another has come closer to solution through the studies of heredity and particularly the mechanism of heredity contained within the germ cells. There are found the chromosomes and their genes. The location of the genes, which are so small as to be nearly at the limit of microscopic vision, is a great step forward. X-rays have been found to scramble the heredity of plants and animals by their effects upon the genes. In most cases this induced evolution is in reverse, producing monstrosities, but in one out of thousands of cases there is the possibility that a new and useful plant or animal strain will result. Vitamins have definitely left the laboratories where they were discovered and entered daily life. Even advertising uses them as springboards. Synthesis last year of vitamin E, the anti-sterility factor, which was discovered in 1922, is the latest major vitamin achievement. The use of ultraviolet irradiation in the production of the antirachitic vitamin D is of industrial and therapeutic importance.

12. One of the most encouraging chapters in civilization's history is the accelerating conquest of disease and the lengthening of normal life expectancy. The last 15 years have seen a number of diseases removed from the list of those that run wild to the list of those potentially under control. Insulin, presented by medicine to the suffering world in 1922, is practically a specific for diabetes. Scarlet fever's cause, antitoxin treatment, susceptibility test, and preventive inoculation were achieved in 1924. Liver extract was shown in 1926 to conquer pernicious anemia as effectively as insulin treats diabetes. Another disease conquered by hormone therapy is Addison's disease, successfully treated since 1930 by extract of the cortex of the adrenal glands. Relatively new diseases arise to plague us, such as tularemia or parrot fever. In the past year investigations indicate the possibility of a link between the non-living and the living worlds. Some of the most important diseases, such as colds, influenza, infantile paralysis, smallpox, etc., are caused by what have been called viruses, too small to be seen through the microscope. Similar virus diseases in tobacco and tomato plants have been traced to small crystals of non-living protein material, that act in some respects as though they were alive. Such crystal "germs" may soon be found in the human diseases.

13. The ancestry of man has been illuminated by recent researches. A few years ago the idea that man existed in America more than a few thousand years ago was not credited seriously, but today tools of undoubted human origin are being found associated with animals known to be long extinct. It is fairly certain that man existed in America as early as 10,000 B. C. Nearly a million years old, Peking man was discovered in China in 1930, another important early man ranking with famous Pithecanthropus erectus. Diggings in the Old World have also shown that the Neandertalers, squat low-browed human race, probably not in the direct line of the ancestry of modern man, lived in Asia as well as Europe.

14. The more recent pre-history of man, before the written record, but preserved in the tombs, ruined cities and other traces of past civilizations has had some brilliant episodes. The world thrilled to the discovery of King Tutankh-Amen's tomb in 1922, to the uncovering of the royal tombs of Ur of the Chaldees in 1928 and the spectacular Monte Alban tomb in 1932 that gave a rich view of ancient American life.

15. Most baffling of all subjects within the realm of science is man's mind and personality. What is mental normalcy? Why does one person in 25 cross the hazy border between sanity and mental disease? Important strides have been made toward the quantitative measurement of mental ability and intelligence. Mental, alertness and aptitude tests have come into use in schools and industries to fit individuals into situations best suited to their abilities. Psychology and psychiatry may be called the infants among the sciences. In recent months study of the so-called brain waves, electrical impulses from the brain, are intriguing experimenters but it is too early to say that they will illuminate some of the great mysteries of the mind.

Let us leave the past and look into the future of science. One is tempted to discuss such immediate matters as short-wave radio, television, rockets to the stratosphere, technologic unemployment, that is, whether we can fit our ingenious machines into our economic life so that they aid rather than compete with human labor.

Instead, I wish to list four great fields of conquest for the science of the future, conquests that we may never see, problems that may well take years of research before a glimmer of effective results is obtained.

1. The conquest of two great killers, cancer and organic heart disease, and that troublesome endemic, the common cold.

2. Development of energy resources that will free us from our dependence upon fossil fuel of the past, such as oil and coal. This probably means the harnessing of solar energy to do practical work, or the release of sub-atomic energy.

3. Understanding of mental disease and the make-up of human personality to the extent that peace and fair dealing may dominate the conduct of individuals, communities and nations.

4. Discovery of the secret of life, that is, the difference between inanimate and living matter, and the creation of artificial life.

This unending penetration into the unknowns of nature and man is, at the same time, the oldest and the newest of human aspirations. The ancients realized its intricacies and pitfalls. Across the facade of that great marble building of the National Acadamy of Sciences and the National Research Council in Washington, in which Science Service has its headquarters, there are engraved in stone these words of Aristotle:

"The search for truth is in one way hard, and in another easy, for it is evident that no one can master it fully, nor miss it fully. But each adds a little to our knowledge of nature, and from all the facts assembled there arises grandeur."

There is a grandeur in science, a grandeur of the mind that scales to the heights of religious feeling, and a grandeur that builds the physical civilization that can give us all abundant necessities and luxuries for a secure and fruitful living. There is a grandeur that protects the family and the nation in peace and war.

The Things of the Spirit

By PRESIDENT FRANKLIN D. ROOSEVELT

Broadcast from Hyde Park, N. Y., in connection with the observance of Brotherhood Day by the National Conference of Jews and Christians, February 23,1936.

I AM happy to speak to you from my own home on the evening of a Sabbath day which has been observed in so many of your home communities as Brotherhood Day. The National Conference of Jews and Christians has set aside a day on which we can meet, not primarily as Protestants or Catholics or Jews but as believing Americans; a day on which we can dedicate ourselves not to the things which divide but to the things which unite us. I hope that we have begun to see how many and how important are the things on which we are united. Now, of all times, we require that kind of thinking.

There are honest differences of religious belief among the citizens of your town as there are among the citizens of mine. It is a part of the spirit of Brotherhood Day, as it is a part of our American heritage, to respect those differences. And it is well for us to remember that this America of ours is the product of no single race or creed or class. Men and women—your fathers and mine—came here from the far corners of the earth with beliefs that widely varied. And yet, each in his own way laid his own special gift upon our national altar to enrich our national life. From the gift that each has given, all have gained.

This is no time to make capital out of religious disagreement, however honest. It is a time, rather, to make capital out of religious understanding. We who have faith cannot afford to fall out among ourselves. The very state of the world is a summons to us to stand together. For as I see it, the chief religious issue is not between our various beliefs. It is between belief and unbelief. It is not your specific faith or mine that is being called into question—but all faith. Religion in wide areas of the earth is being confronted with irreligion; our faiths are being challenged. It is because of that threat that you and I must reach across the lines between our creeds, clasp hands and make common cause.

To do that will do credit to the best of our religious tradition. It will do credit also to the best in our American tradition. The spiritual resources of our forebears have brought us a long way toward the goal which was set before the nation at its founding as a nation.

Yet, I do not look upon these United States as a finished product. We are still in the making. The vision of the early days still requires the same qualities of faith in God and man for its fulfillment.

No greater thing could come to our land today, than a revival of the spirit of religion—a revival that would sweep through the homes of the nation and stir the hearts of men and women of all faiths to a reassertion of their belief in God and their dedication of His will for themselves and for their world. I doubt if there is any problem—social, political or economic—that would not melt away before the fire of such a spiritual awakening.

I know of no better way to kindle such a fire than through the fellowship that an occasion like this makes possible. For Brotherhood Day, after all, is an experiment in understanding; a venture in neighborliness.

I like to think of our country as one home in which the interests of each member are bound up with the happiness of all. We ought to know, by now, that the welfare of your family or mine cannot be bought at the sacrifice of our neighbor's family; that our well being depends, in the long run, upon the well being of our neighbors. The good neighbor idea—as we are trying to practice it in international relationships—needs to be put into practice in our community rela-

tionships. When it is we may discover that the road to understanding and fellowship is also the road to spiritual awakening. At our neighbor's fireside we may find new fuel for the fires of faith at our own hearthside.

It would be a fitting thing for an organization such as the National Conference of Jews and Christians to undertake this kind of a project in neighborliness. I should like to see associations of good neighbors in every town and city and in every rural community of our land. Such associations of sincere citizens like-minded as to the underlying principles and ideals would reach across the lines of creed or of economic status. It would bring together men and women of all stations to share their problems and their hopes and to discover ways of mutual and neighborly helpfulness. Here, perhaps, is a way to pool our spiritual resources; to find common ground on which all of us of all faiths can stand; and thence to move forward as men and women concerned for the things of the spirit.

The Nation's Sounding-Board

PLEA FOR TEMPERATE SPEECH

By OWEN D. YOUNG, *Chairman of the Board, General Electric Co.*

Rollins College, Winter Park, Florida, February 24, 1936.

MR. PRESIDENT and members of the convocation: Some days ago we listened to the Rollins College Animated Magazine of the Air. One could not help being impressed with the charm and power of the spoken word. Its very fleeting quality compels attention. Its very evanescence is what Burns described:

"But pleasures are like poppies spread;
You seize the flower, its bloom is shed.
Or like the snow falls in the river,
A moment white—then melts forever."

Science has at last combined the human voice with a sounding-board of such dimensions that it may be heard by all the people of this earth. Only once before could that be done, at least so it is recorded in "Paradise Lost,"

"When Adam first of men,
To first of women Eve, thus moving speech
Turn'd him all ear to hear new utterances flow."

What Adam may say to Eve, with her instinctive powers of discrimination, is one thing, but what one may say before the sounding-board of the world is another. Good-will or bad-will, understanding or misunderstanding, cooperation or contest, peace or war, may depend on the spirit, on the wisdom, on the self-restraint of him who, for the moment, controls the mighty instrument which modern science has put into his hands.

The preservation of the right of free speech, gained after bloody battles and enormous sacrifices, now depends upon the exercise of wise discretion by him who undertakes to speak before this giant reflector of his voice. Freedom of speech for the man whose voice can be heard a few hundred feet is one thing. Freedom of speech for the man whose voice may be heard around the world is another. We defend them both and will to the uttermost, but we cannot be blind to the increasing dangers of carelessness or intemperance in their use.

Sunlight is the conservator of life and health upon this earth, but a magnifying lens can concentrate its rays sufficiently to start a conflagration. No one would deny the right of a man to bask lazily in the sunshine of Florida, but the moment a magnifying lens is put in his hands he becomes a trustee for others. No one would deny freedom to the man who carries his food on his back, but when he substitutes the ox-cart and ultimately the motor car as his carrier his responsibilities to others progressively increase.

I speak of these common and well-known things only to suggest that in our modern society freedom of the individual moves progressively toward trusteeship as one undertakes to use these powerful instruments which modern science has put into his hands. There is no better illustration than that of the central power plant of a great city.

Recently in New York, due to an unavoidable accident, the electric service was interrupted sufficiently to impress upon us the importance of this focal point. Transportation was paralyzed, both horizontally and perpendicularly, the safety of life and property was immediately impaired, critical operations in hospitals were delayed, interruption of the food supply was threatened.

So we subject the most vital things in life to the reliability of a machine and to the conscience and care of him who runs it. A few men in the great power stations of the nation, unknown and unsung, perform a trust more far-reaching in application, more devastating in its default than that exercised by the trustees of our stocks and bonds.

It is one thing to turn a fanning mill on the farm by hand, it is another to care for a great central power station on which millions of men may depend. Carelessness in the first may mean a pinched finger; recklessness in the second may mean catastrophe.

The radio transmitter is one of the great central power plants of public opinion, and public opinion is the master of our politics. Yet, somehow in the field of politics, we are demanding no greater responsibility than in the days of the fanning mill. The same extravagance of statement, the same carelessness, the same appeal to emotions, which stirred the audience in the ballroom of the country hotel 100 years ago, is freely resorted to yet, before the great central sounding-board of a nation. The gibe, the exaggeration, the exuberance, even though rhetorical only, which may have relieved the lonely pioneer on his way home over a muddy road, and so have been excusable, may become, when uttered by a voice of great authority before a master sounding-board while millions listen, an agency of irremediable injury.

Surely the shot at Concord Bridge may be heard around the world. If it sound the knell of tyranny, one would wish it so; but if it be the birth of tyranny, then all living who

have enjoyed the benefits of liberty, and all dead who have paid its price, may well stand in fear of that fateful sound.

Why do I speak so long of what you know? It is only to make a specific application. We are facing a political campaign of wide interest and vast importance. Politics for the time being is dominant. It is the master of our economics. It may dictate our living standards. It may decide whether government is a servant of the people or whether it is their master. Never before in our time have we faced such momentous political questions; never before has there been a more eager or sensitive audience.

From time to time men of great influence on this mighty force of public opinion stand before this nation-wide reflector of their voice. They are men of ability, of understanding, of integrity, of sympathy, otherwise, they would not wield such influence. What they say, how they say it, and in what spirit they say it is of major consequence to us all. On their individual freedom to speak there is superimposed in a very real sense a kind of trusteeship for the nation. No rules can be laid down to govern a matter so sensitive.

> "Case cookin's lak religion is—
> Some's 'lected and some ain't,
> An' rules don' no mo' mek a cook
> Den sermons make a saint."

When master voices in the field of politics are sounded throughout the nation, when they knock at the door of every home, what a responsibility there is attached to them.

Three men, whom I much admire, have recently spoken before this sounding-board of the nation. Each was listened to by millions. I shall quote from their statements briefly:

The former President of the United States, Mr. Hoover, speaking of a managed currency, said:

"But behold! Our mystery fund has been most successful in stablizing our currency to within a few per cent of the pound sterling for over a year. We have attained that stability which comes from leaning up against the British. We are the thirty-first member of the 'sterling bloc' of nations.

"Let us remember that the British also have a managed currency and in the 'sterling bloc' we are only one of the thirty-one planets which revolve around the British sun. We have thus trustingly reposed in London a large influence in American values and freedom of American trade.

"I do not pretend to know where all this will take us, but I do know that I prefer a currency that no 'national planning' can manage for us, not even the British."

Governor Smith has said:

"Now in conclusion, let me give this solemn warning: There can be only one atmosphere of government, the clear, pure, fresh air of free America, or the foul breath of communistic Russia. There can be only one flag, the Stars and Stripes, or the flag of the godless Union of the Soviets. There can be only one national anthem, 'The Star-Spangled Banner,' or the 'Internationale.' "

Senator Robinson has said:

"Yes, Governor Smith not only has changed sides in the great battle but his whole outlook seems to have undergone a transformation. He has forgotten apparently the issues upon which he ran for the Presidency. The brown derby has been discarded for the high hat; he has turned away from the East Side with those little shops and fish markets, and now his gaze rests fondly upon the gilded towers and palaces of Park Avenue.

"Somehow I think there must be two Al Smiths. One is the happy, carefree fellow behind whom we marched and shouted in 1928, proud of his principles and eager to place him in the White House. Now we have this other Al Smith, this grim-visaged fellow in the high hat and tails, who warns us that we are going straight to Moscow."

Without questioning their right to freedom of speech, without inquiring as to the sincerity of their belief, one may well ask whether such statements are a wise exercise of the great powers and responsibilities of trusteeship which these men hold.

These are times of confusion and bewilderment. Is it any aid to the solution of the sensitive and critical issues before the people of this nation to say that the currency of the United States revolves around the British sun? Is it any aid to say that the people of this nation must now choose between the Stars and Stripes and the red flag of Moscow? Is it any aid to challenge the magnificent spirit of Governor Smith and to charge that his great sympathy with and understanding of the common man have been impaired because he moved from the East Side to Park Avenue?

One welcomes careful analysis and fearless debate, which aid us to find our way. We need as never before cool heads. We need as never before to avoid prejudice and passion. We need as never before to escape the heat and to seek the light. The lonely engineer in the power plant, in the exercise of his great responsibility, never risks sand in the sensitive bearings of his great machine.

Then, too, it is not alone what the great masters say. They make the pattern; they set the fashion. Lesser voices are speaking too, with an even greater abandon. Such I need not quote, for the air is becoming increasingly filled with the intemperance of emotion and of prejudice.

Perhaps oratorical license may be excused if it be confined to the natural range of the human voice. Perhaps it has no place before the sounding-board of the nation. Perhaps one may take liberties with the old hand-driven fanning mill. Perhaps they must not be taken in the great central power plant. Perhaps a man has a right to pinch his finger in one, but has no right to invite catastrophe with the other.

At the end of a political campaign, when men are tired and irritated and emotions inevitably run high, we may excuse, even though we deplore, an appeal to passion and an outburst of irritation. But at the beginning of this year, with so many months ahead, may we not ask the great masters of our political machine, sitting in these great central power stations which so deeply influence public opinion, to exercise that conscientious care and restraint which these sensitive and powerful modern instruments require?

Especially may we not ask it now, when so many suffer and are in trouble; when so many are conscientiously trying to find their way; when difficulties are high and spirits low; when consequences of mistakes may plague us and our children always?

To these great men, and even to the President of the United States, all held in such high esteem, may we not appeal for the choice word and the measured phrase, spoken with malice toward none and charity toward all?

A Layman Looks at the Supreme Court

By ARTHUR H. VANDENBERG, *Senator from Michigan.*

Over N. B. C., Washington Star Radio Forum, March 2, 1936.

I RESPOND to the subject—"A Layman Looks at the Supreme Court." I am *not* a lawyer. This is neither a boast nor an apology. It is simply a statement of fact. Lawyers usually monopolize the discussion of constitutional questions. But there are many more laymen, fortunately, than lawyers. Therefore, a layman's view may be tolerated in the present discussion which rumbles up and down the country and intermittently breaks hotly in the Congress and the White House.

The cause of these discussions is that the Supreme Court is repeatedly stopping Congress and the President in enterprises which violate the Constitution. This has happened ten times since March 4, 1933. In anticipation of similar inevitable denunciation. Congress itself has repealed a number of its other recent laws. Promptly an age-old controversy resumes. Since the foundation of the Republic whenever Congress and the Court have thus clashed, impatient agitation has argued that the Supreme Court's authority over the constitutionality of acts of Congress ought to be abolished. Although the Court has repudiated only 62 acts out of 24,300 public laws since the beginning, each time it happens there is the cry that Congress must be released from this Court veto. In this layman's view, *if any such movement ever succeeds it will be a sad day for popular government, and for the perpetuation of American liberties.*

It will simplify our thinking if we realize that when an act of Congress is thus rejected, it is THE CONSTITUTION which is speaking. That means, in turn, that it is THE PEOPLE speaking. The Supreme Court, in such instance, is only THE CONSTITUTION'S VOICE. The Judges are not passing their opinions upon the intrinsic merits of the law. Their sole responsibility is to reject the law if it violates the Constitution. The judges are human. Their judgments may err. But somewhere, some how, some time, in our American system, *some* body must speak for the Constitution in this precise fashion or, manifestly, the Constitution becomes mute and impotent. Better to risk occasional error of interpretation than to risk the loss of ordered liberty. This is our choice.

It is our theory of government that the Constitution belongs exclusively to THE PEOPLE. They fought for it. They died for it. They wrote its guarantees. Into it they put those inalienable warrants which set American liberty apart and make it the grandest thing on earth. To make certain that THE PEOPLE should never be robbed of its protection, the founders provided that none but THE PEOPLE can ever change it. They prescribed, in the Great Charter itself, just how it may be amended. It thus has been amended 21 times. That makes of it a living, progressing thing. But it is impregnable to any attack save by THE PEOPLE themselves; and any time it loses this granite character, it will be THE PEOPLE who have been victimized. It may be changed; but it *must* not be cheated.

Now, in order to protect this popular right, the founders realized they had to provide checks and balances. They had to defend the Constitution against nullification and usurpation. So they wisely—as every lesson of the years has proved—separated the executive, legislative and judicial functions. They set up the Legislature to legislate and the Executive to execute; then they provided an independent Judiciary to require each to respect the rights of the other, and to require *both* to respect the rights of THE PEOPLE. Thus the Supreme Court became the *voice of the Constitution* which, remember, is, in turn, the *voice* of THE PEOPLE. Today's recurrent question is: SHALL this VOICE be stifled?

The founders of America knew exactly what they were doing. They knew that if Congress could decide whether its own acts are constitutional, the entire American system would be flung to transient politics. The Constitution—and its sacred guarantees—would become whatever each succeeding Congress might want to make it. It would change with the ebb and flow of each election. The rock whence we are hewn would become the shifting sand-pit in which the rights of THE PEOPLE could sink to destruction. The founders discussed it very frankly.

Patrick Henry, who was the great liberal of his time, said in the Virginia Constitutional Convention:

> "I take it as the highest encomium that the Acts of the Legislature, if unconstitutional, are liable to be opposed by the Judiciary * * * *The Judiciary are the sole protection against a tyrannical execution of the laws."*

Remember that warning! The Supreme Court protects THE PEOPLE against tyranny!

John Hancock, who wrote his name upon our Declaration of Independence where all time shall see and honor it, said:

> "Lest the pride of office or the hand of lawless power should rob THE PEOPLE of their Constitutional security, a proper balance is provided in the Judicial Department."

Hamilton and Madison, collaborating in the production of the illuminating and authentic Federalist Papers to expound the new American System said:

> "An ELECTIVE DESPOTISM was *not* the government we fought for. * * * * For this reason, the Constitution required that the Legislative, Executive and Judiciary Departments should be separate and distinct, *so that no person should exercise the powers of more than one of them at the same time.*"

Are we such egotists in this new day that we think to escape the implications of this wisdom? Listen: "AN ELECTIVE DESPOTISM WAS NOT THE GOVERNMENT WE FOUGHT FOR"! No: and it is *not* the government which THE PEOPLE of the United States will embrace in 1936 or in any other year, *if they intend to protect themselves against the tyrannical trends towards dictatorship which are engulfing the balance of the world.*

The Federalist Papers wisely said:

> "Limitations only can be preserved by the Courts whose duty it must be to declare all act contrary to the

Constitution void. * * Without this, *all our rights and privileges would amount to nothing.*"

I take it that no loyal American citizen wants his rights and privileges "to amount to nothing." Here he is put on direct notice that he hazards their loss when he would poison the constitutional jurisdiction of the Courts.

As laymen, let's be practical about this matter. Let's see what *could* happen if you eliminate the Supreme Court and permit Congress to decide the constitutionality of its own acts. It is not enough to say that these things probably wouldn't happen. That begs the question—particularly at a time when amazingly unbelievable things *are* happening under every flag on earth. The priceless function of our own Constitution—*and its voice in the Supreme Court*—is to see that no opportunity for such perversions shall exist.

You cherish your right of free speech. What guarantees it to you? The Constitution. Suppose Congress were to abridge or destroy your right of free speech. Where could you go for redress? To the Supreme Court. But suppose the Supreme Court be eliminated and Congress be permitted to decide the constitutionality of its own acts. Would not a Congress which was brazen enough to rob you of free speech be equally brazen in finding excuses to validate its tyranny?

You believe in freedom of religion. It is a cardinal American right. Where do you get it? From the Constitution. Suppose it is assailed by law—as is the case tonight in many another land. Where would you go for protection? To the Supreme Court. But suppose Congress decides for itself what is or is not constitutional. Would not a Congress which dared curb your religious freedom dare equally to validate its own act? Would not this be "elective despotism"?

You believe in a free press. It is the well-spring of democracy. What guarantees its freedom? The Constitution. Who speaks for the Constitution in behalf of this guaranty? The Supreme Court. Would you think it safe or wise to strike down this vigilant sentry? Time and again the Court has rescued freedom of the press from its assailants. Only last week, the Court rescued it from a State Legislature which would have put it in chains. No other agency *could* rescue it. It was the Court—or nothing. Translate that same situation into federal legislation. Would it be prudent to let Congress decide for itself whether it has raped the freedom of the press? Would not any such assailant inevitably insist that his tyranny was orthodox and respectable? Is that not the way with tyrants?

So it is all down through the Bill of Rights—your right of petition—your protection against search and seizure—the sanctity of your home—your right of trial by jury—your right to own private property—your protection against cruel and unusual punishment—your ballot—your entire American heritage. Whether you know it or not you are relying upon the CONSTITUTION for these privileges, and you are relying upon the SUPREME COURT to make the Constitutional vocal and effective in your behalf.

Would it be prudent to toss this protection away just because sometimes you dislike the Court's decisions? Most of the time you are so completely in tune with it, and you sub-consciously rely so completely upon its vigilance, that you scarcely realize it is functioning at all. Those who dislike its conclusion on the A.A.A. suddenly discover that it is a pretty dependable tribunal when it passes on T.V.A. This phenomenon has been constant through the years. Those who are inclined most vehemently to complain at one moment, usually live to see the day when, at some other moment, they whole-heartedly applaud. Thus the great South which, originally, was the chief critic of the Court's so-called "usurpation" in decisions amplifying federal authority at the expense of State sovereignty, turned to the same Court in Reconstruction Days and gratefully gained protection from it against an improper exercise of this same amplified authority. Thus, too when labor unions were shocked in 1908 when the Court found that a labor boycott violated the Sherman Act and proclaimed it an evidence of the servility of the Bench to "Big Business," they totally forgot how equally shocked "Big Business" had been when the same Court in 1897 found that "railroad pools" were illegal under the same Act.

So it always has been and will be. The Supreme Court honorably and conscientiously goes its unruffled way and bravely functions under its constitutional responsibility. It does not seek to please an electorate. It woos no constituency. Its only master is the Constitution whose only master is the people. It may be popular or otherwise; it may be right or wrong; but one thing is certain—it is absolutely indispensable to the American system and to the preservation of American liberty.

Carry the inquiry a little farther. Suppose Congress and the Executive concluded to perpetuate themselves; to extend their terms; to cancel elections. What is to prevent? The Constitution. How? Through the Supreme Court. Is there any other veto? No. Suppose you strike down the Court, and let Congress review its own works. Suppose you make Congress and the Executive supreme. What becomes of THE PEOPLE'S sovereignty?

It is no answer to say that such hypothesis is fantastic or that it would be too revolutionary to be stopped even by the Court. Exactly this sort of thing has happened elsewhere. The founders of the American system were near enough to these examples to know their menace. The British Parliament—unchecked by a written Constitution, rendered articulate by a Supreme Court—on several occasions changed the period of election; in one instance continuing itself in place four years beyond the term for which elected by the people. Indeed, under the British system, Parliament can do no wrong. A recent book by a former British Cabinet member has said:

> "Parliament could pass a law that every red-headed man should be hanged, and the Courts of Law would have to carry out its bidding."

Is that sort of thing, or any part of it, a desirable substitute for the American system? I repeat, it is no answer to say that no American Congress and no American Executive would so far transgress the constitutional order. An excellent test of any proportion is to assess its ultimate and extreme possibilities. No man knows what would happen if we should let down the bars—particularly at an hour when the whole world is restless with new dictatorships. We might revert to type. Once upon a time the State of Pennsylvania had a "Council of Censors" to inquire whether the Legislature and the Executive had exceeded their constitutional powers. It found many such occasions—even that "constitutional trial by jury had been violated."

Can it possibly be progressive to invite an American renaissance of these outrages upon our conception of a

people's government? Can there be any logical *liberalism* in emasculating the people's primary defense of their own sovereignty under the American Flag? This layman does not think so. He believes that all these threats to the existing independence of the Supreme Court and its right to call Congress and the Executive to account in the name of the Constitution, no matter how nobly meditated, are threats to the fundamental liberty of THE PEOPLE themselves.

This conclusion by no means supposes a greater patriotism in the Court than in the Congress. It only recognizes the reality that their functions are separate and different. The Court could no more be trusted both to legislate and to judge than can the Congress. It is the separation and division of these prerogatives that counts.

This conclusion by no means supposes a superiority of the judicial to the legislative power. It only supposes that the power of the people is superior to both; and that where the will of the Legislature, declared in its statutes, stands in opposition to that of THE PEOPLE, declared in the Constitution, THE PEOPLE have a right to rule. Their only reliance at such a moment is an untrammeled Supreme Court. This does not make the Supreme Court the *actual* ruler of America. That is a subtle, self-serving sophistry. It does not put the Court above Congress. It merely puts the Constitution above both—and that is precisely where it belongs, and where it is going to stay if The Republic shall survive.

You can never make a tyrant out of the Supreme Court. It lacks one single power of affirmative enslavement. It can not take one single step toward oligarchy. But you can make any sort of monster, suited to the prevailing appetite of the ruling passion, out of a Supreme Court which is above all things and all men. Again I quote The Federalist Papers:

> "To accumulate in a single body all the most important prerogatives of sovereignty is to entail upon our posterity one of the most execrable forms of government that human infatuation ever contrived."

Proposals to escape the existing jurisdiction of the Supreme Court periodically take differing forms. Sometimes, it is urged that Congress be freed entirely from restraint. Sometimes it is urged that more than a majority of the Court be required to stop a Congressional invasion of the Constitution—perhaps that a unanimous Court be required. These latter propositions differ only in the matter of degree. The same infirmity, from THE PEOPLE'S viewpoint, attaches proportionately to all. For example, if a unanimous Court be demanded, *one* Justice out of *nine* could stifle the voice of the Constitution. Thus one-ninth of the Court would out-weigh eight-ninths. All of these schemes would increase the presumptions in favor of Congress and relatively decrease them in favor of the Court.

This layman believes that the direction, even more than the length, of such proposed steps is subversive of the American system. The length to which the Judiciary can *permanently* usurp legislative power is utterly limited—because THE PEOPLE can amend their Constitution if, as and when they please, and the Congress can impeach the Court if it misbehaves. Furthermore, the Court has no power to enforce its decisions save the power of a loyal and enlightened public opinion. It commands neither the arms nor the purse of the nation. But the extent to which the Legislature and the Executive can usurp Judicial power, in the absence of these American checks and balances, is wholly without any limits whatsoever. *They* command every implement of tyranny. Therefore, though some may think that the former evil exists in some degree, THE PEOPLE will find it infinitely the lesser of two evils if they are wise in the vigilance with which they defend and preserve their birth-right.

If we ham-string this function of the Judiciary, we deliver ourselves to a new formula under which "special privilege" would have to control but one Congressional election in order to dominate the United States and write its uncensored ultimatum into the lives of a defenseless people. Or we deliver ourselves to a formula under which a revolutionary order need but capture a single November referendum in order to bind our nation to whatever subversion the passion of an inflamed moment might prescribe.

This layman rejects any such invitation to jeopardy. Therefore, this layman looks upon the Supreme Court with deepest attachment and respect—not because it is a Court—not alone because of the consistently high character of its personnel—but because it is the *voice of the Constitution* which, in turn, is *the voice of the American people themselves.*

Measuring Public Opinion

By DR. GEORGE GALLUP, *Director of the American Institute of Public Opinion.*

Before the American Institute in Rockefeller Center, New York City, January 16, 1936.

(Dr. Gallup spoke from notes at the time, but at the special request of the editors of VITAL SPEECHES *has written the following resumé of what he said.)*

IT is the fashion today in some circles to bemoan the lack of intelligence of the American electorate. Pessimistic critics of the social scene assert lugubriously that, whatever may have been the condition in the past, the American voter of today is incapable of self-government. We have all heard that "the majority is always wrong," and that "the average American has the intellectual ability of a child of twelve."

But, both now and in the past, distinguished gentlemen have expressed quite contrary views.

President Franklin Delano Roosevelt in his Jackson Day address, scarcely more than a week ago, said with reference to President Andrew Jackson:

"He adhered to the broad philosophy that decisions made by the average of the voters would be more greatly enduring for, and helpful to, the nation than decisions made

by small segments of the electorate representing small or special classes endowed with great advantages of social or economic power."

In that same address Mr. Roosevelt expressed his own point of view in these words:

"A government can be no better than the public opinion that sustains it."

One of the few foreign commentators Americans have ever paid any attention to was Lord Bryce. As England's ambassador here he prepared his great work, *The American Commonwealth,* and it became for a generation the standard analysis of American democracy.

Bryce wrote that a final stage in the evolution of democracy would be reached "if the will of the majority of citizens were to become ascertainable at all times." That was in 1891.

In 1922 it was an American commentator. It was Walter Lippmann, writing in *Public Opinion:*

". . . the troubles of representative government, go back . . . to the failure of self-governing people to transcend their casual experience and their prejudice by inventing, creating and organizing a machinery of knowledge."

Three American presidents, other than Franklin Roosevelt, have left a flashing record in words of their reliance on the people's opinion.

In his first inaugural address, President Lincoln asked the crowd at the steps of the Capitol:

"Why should there not be a patient confidence in the ultimate justice of the people? Is there any better or equal hope in the world?"

Woodrow Wilson in 1911 said:

"I would rather hear what men are talking about on trains and in shops and by the firesides than hear anything else, because I want guidance and I know I could get it there."

And Theodore Roosevelt in 1908 said:

"I believe the majority of the plain people will day in and day out make fewer mistakes in government themselves than any smaller class or body of men will make in trying to govern them."

The issue raised in these quotations seems to me of the highest importance if government of the people, by the people, and for the people is to endure.

Are Americans today capable of self-government?

My whole training has been to obtain answers to questions, even of this sort, on a scientific basis rather than on an emotional basis. Quotations do not prove anything. The demand, as I see it, is for facts to substantiate or to disprove the quotations.

During the last few months the Institute of Public Opinion has measured public sentiment on many of the major issues of the day. It seems to me that an approach, at least, to weighing the people's ability for self-government can be made by study of the facts about public opinion discovered and reported by the Institute of Public Opinion.

Before I tell you the facts about current public opinion, I should like to describe briefly the scientific manner in which those facts about opinion are obtained. We operate what amounts to a continuous poll of the voters of the country. Thousands of ballots are mailed from our office in Princeton, New Jersey, every day, and they come back every day. We employ a staff of more than 150 trained investigators who supplement returns from the mailed ballots by interviewing voters face to face. Once a week we report through a group of leading newspapers—Republican, Democratic and Independent—public sentiment on one significant issue of major importance.

You are probably all fairly well familiar with the way straw votes have been conducted in the past. Sometimes ballots are printed in a newspaper; sometimes reporters distribute ballots in street cars, on the street, to movie audiences and at gatherings of one kind or another; sometimes ballots are mailed to persons whose names are listed in telephone directories and other similar compilations. But all these methods have one serious disadvantage if you are looking for a result that will approach scientific accuracy. Sending ballots broadcast fails to obtain an accurate result because there is no control on the accuracy of the cross-section of the population reached.

A scientific poll should reach voters in the same proportion that these voters exist in the community being polled. If a result is to have nation-wide accuracy ballots must, for one thing, come back from each state in proportion to the voting population of that state. When votes are returned in those proportions statisticians say that the cross-section, to that extent, is controlled.

Polls of the Institute of Public Opinion employ five controls. The first one is the one I have just mentioned: that of receiving ballots from each state in proportion to its voting population. But we have found four other controls are necessary if we are to obtain an accurate result. In each state we insist on getting ballots in correct proportion from persons who live on farms and from persons who live in cities. We must receive ballots in correct proportions from persons at various income levels, particularly from persons at or near the relief level. Furthermore, we have to hear from the correct number of persons who have come to voting age since 1932. And, finally, we must maintain correct proportions among persons who voted for Roosevelt, Hoover, Thomas and others in 1932. As you can appreciate, a tremendous amount of statistical work is necessary to maintain these five controls, but if they are not maintained the result of a poll may mean little or nothing.

There are, of course, vital issues on which persons in all groups divide in about the same proportion. For a question of this nature any kind of cross-section will give a reasonably satisfactory answer. But, for most questions, persons in one or more groups of the population divide quite differently from persons in other groups. And to get a correct answer for questions of this sort it is absolutely necessary to receive ballots from each group of persons in proportion to its numerical strength in the country as a whole. When you do that, you are operating a scientific poll; when you do not do it, you are conducting a straw vote.

How accurate will a scientific poll of opinion be?

If you poll an accurate cross-section, and if you send out, as we normally do, between 100,000 and 200,000 ballots on each issue, the result will not differ by more than a per cent or two from the result that would have been obtained if ballots had been sent to the forty million persons who ordinarily vote in a national election. Statisticians have proved this mathematically. Our own experience has shown the truth of this statement empirically.

In one test poll conducted during the nearly two years I experimented in discovering how to select an accurate cross-

section, the result came within six-tenths of one per cent of the official figures for the Congressional elections a year ago last fall. This fall in the only three states in which statewide elections were held—New York, Kentucky, and Pennsylvania—our figures averaged to be accurate within about two per cent, and this very small difference was due, we think, principally to the fact that the question asked on our ballots had to do with presidential candidates, whereas the voters in these three states actually voted for state officials.

Money for financing the expense of the polls of the Institute of Public Opinion comes entirely from the newspapers that print the reports. These reports are sold to newspapers in the same way that a news service is sold. The Institute of Public Opinion has no sponsors; it needs no subsidies. It is self-supporting. A further guarantee of the impartiality of the polls is found in the political affiliations of the newspapers now publishing the results. Seven call themselves Democratic, twelve Independent Democratic, ten Republican, twelve Independent Republican and 27 Independent.

The Institute of Public Opinion is not a pressure group; it is not trying to *influence* public opinion. Its sole function is to *report* it.

But to get back to the question before us this evening: Are the American people capable of self-government?

I am going to tell you how the American people voted in polls conducted by the Institute during the past few months, and I am going to ask you to determine, on the basis of this evidence, whether the people made wise or stupid choices.

One thing ought to be clear at the start. The people will not agree with any one individual on all major issues. That is not to be expected. The point to observe is whether the people voted rationally rather than irrationally. Try to divorce yourself from all your preconceived ideas and prejudices. Imagine you are the mythical Man from Mars who is trying to decide whether the inhabitants of Earth have the brains to know what is good for them.

Each question that found its way into the ballots of the Institute had first found its way into keen public discussion; each represented, in the concensus of editors, a vital contemporary issue.

Here are the results.

Last October the question asked was: Are government expenditures for relief and recovery too great, too little, about right? The result: Too great, 60%; too little, 9%; about right, 31%. Is this answer: 60% too great, 9% too little, 31% about right, a sensible answer under the conditions?

In the fall we asked a question with reference to limiting the power of the Supreme Court to declare acts of Congress unconstitutional. This was after NRA had been held unconstitutional but before the recent decision on AAA. The result, among those who had an opinion, was approximately 5 to 3 against limiting the court's power. Again I ask you, is that a reasonable difference of opinion among the voters of a free people?

Then we asked a question about liquor. We inquired about conditions in the locality where each voter lived: Are conditions with respect to the use of alcoholic beverages better, worse, about the same compared to conditions during the last few years of Prohibition? The result: An almost even split among the three choices: Better, Worse, About the same. A significant feature of this poll was that two young persons out of three said conditions are better.

In a later poll seven persons out of ten voted for a policy of isolation in response to the question of joining with other nations to prevent a war between two foreign nations.

The voters in our cross-section voted 55 to 45 in favor of paying the bonus in cash now. The poll came about one month before the almost unanimous action of Congress. In a poll taken nearly a year before we had found 48% in favor of paying the bonus at that time only to needy veterans. Twenty-two per cent were in favor of paying it only when due in 1945, with only 30% asking for immediate cash payment to all veterans. Well, the question still is: Are the people better capable of governing themseves than some smaller body of men is capable of governing them?

About the middle of December we reported on one of the most interesting polls we have conducted. The question was: What do you think is the most vital issue before the American people today? Each voter had to write in his choice. The three issues that led the list were: Cure unemployment, Stop government waste, Stay neutral. Does that sound as if the people lack political brains?

In a poll on appropriations for the armed services of the United States, reported December 29, the result was: Increase appropriations for the Army, 48%; for the Navy, 54%; for the Air Force, 74%. Is that a stupid ratio?

The day before the Supreme Court by a vote of 6—3 declared AAA unconstitutional, we reported on this question: Are you in favor of the present administration's agricultural policy as embodied in the AAA? The result: Favoring AAA, 41%. Against AAA, 59%. Do the people exercise judgment about significant major issues?

In favor of old age pensions, the country in our most recent poll voted 9 to 1. The favored eligibility age was 60. The most favored sum asked for each individual was $30 a month and for a husband and wife $50. The median sum asked was $40 for an individual; $60 for husband and wife. One person in 26 favored $200 a month for each individual, and not quite one person in 50 favored $400 a month for a husband and wife.

Now that I have reported to you what the public thinks about nine significant issues of the day, and now that you have had a chance to decide for yourselves whether or not the public by its choice has shown a capacity for self-government, I suppose it is only fair to tell you what these results indicate to me.

Let me admit at the beginning that when I started taking an interest in this question I thought candidates for public office were merely making a play to the rank and file when they spoke of their love for and their trust in the common people. For all I know now, candidates may have no other motives for such statements.

But, as far as I am concerned, I am willing to trust the people to make the correct decision when they have a chance to express themselves on one issue at a time.

I realize that there are at least two sides to any question, but it seems to me the public has an uncanny accuracy at estimating the weight that should be attached to the various arguments. For myself I have no hesitation in living in a country whose everyday citizens feel about major issues as the citizens of our country feel. I am frank to confess that I should rather trust the judgments of the majority than to trust my own individual judgment. If you say, "Let the people rule," you can count me on your side."

Curbing the Court

By EDWARD S. CORWIN, *Professor of Jurisprudence, Princeton University, and former President of the American Political Science Association.*

Over NBC-WEAF network, in the "You and Your Government" program, February 11, 1936.

(This was the second of nineteen programs in the "You and Your Government" series, every Tuesday night, on "The Constitution in the 20th Century," under the auspices of the Committee on Civic Education by Radio of the National Advisory Council on Radio in Education and the American Political Science Association, and the American Academy of Political and Social Science.)

THE unique feature of our government is the great role of the Supreme Court, a small appointive body whose members hold office for life, and whose decisions are arrived at in secret conference. The Court has the power to set aside any act of Congress or of a State legislature which it finds to be unconstitutional, and today this power is exercised on such indefinite grounds as to be virtually without limits. The Court has become, therefore, a kind of superlegislature; in the words of Woodrow Wilson, it is "a sort of constitutional convention in continuous session."

To be sure, the Justices themselves sometimes give us a rather different picture of their function. In the A. A. A. case, Justice Roberts said: "When an act of Congress is appropriately challenged in the courts as not conforming to the constitutional mandate, the judicial branch of the government has only one duty—to lay the article of the Constitution which is invoked beside the statute which is challenged and to decide whether the latter squares with the former." The vison called up is of the nine Justices in their black robes taking the act of Congress and the Constitution into their conference room and looking up in the dictionary the words of the two documents which are supposed to be in conflict with each other, and then coming out and announcing the result.

Unfortunately Justice Stone in his dissenting opinion in the same case, utterly spoils this comfortable picture. He says: "While unconstitutional exercise of power by the executive and legislative branches of the government is subject to judicial restraint, the only check upon our own exercise of power is our own sense of self-restraint."

And Chief Justice Hughes, when he was governor of New York, once said: "We are under a Constitution, but the Constitution is what the judges say it is."

So I repeat, that the Court is today a superlegislature, in the sense that the discretion which it enjoys in setting aside legislative acts is indefinite and undefined. But let me emphasize the word *today* in this statement. Throughout the first seventy-five years of the Constitution the Court set aside only two acts of Congress. On the other hand, in the ten years just preceding Mr. Hoover's presidency it set aside seventeen acts of Congress as unconstitutional, some of them acts of great moment.

And in view of the above facts, the question has been raised, whether the Constitution really gives the Supreme Court this power over acts of Congress. At the same time there are now pending in Congress between twenty-five and thirty proposals for curbing the Court in the exercise of this power. What are the merits of these controversies?

The Constitution does not give the Supreme Court its power over acts of Congress in the clear, unmistakable terms in which it gives the President *his* veto power. Judicial review of acts of Congress is an *inference,* which is based *in part* on words of the Constitution, but also in part on ideas which are not stated in the Constitution; and different ideas would have led to a different result. However, it is plain that the great majority of the Framers of the Constitution drew this inference, though some of them afterwards recanted. Among the latter was "the Father of the Constitution," James Madison. In the Convention of 1787 he favored judicial review; a few months later he rejected it; later still he returned to his earlier view. Other people have shown the same uncertainty on the subject.

One way to curb the Court would be to "pack it" with new members favorable to certain constitutional views; another way would be to require more than a majority vote on the Court in setting aside an act of Congress; still another way would be to deprive the Court of its appellate jurisdiction in constitutional cases. The first and third of these methods, it is generally admitted, would be within the power of Congress, but they are objectionable on other grounds. The Court is already large enough, and *cases* involving constitutional questions have to be decided somewhere; and where more appropriately than in the Supreme Court? One should not forget the old warning not to throw out the baby with the bath.

The Court's power over Congressional legislation is today so vast, that to harmonize it with the idea of "a government of the people, by the people, and for the people", it should be exercised with a considerable degree of responsibility and responsiveness to popular opinion. This seems evident; but how is this result to be secured? My answer is, by getting rid of certain false ideas which have come to attach themselves to judicial review, and especially the idea that when the Court makes an interpretation of the Constitution for the purpose of deciding a *case,* such interpretation must inevitably be regarded by Congress and the President as henceforth a part of the Constitution, which they are bound by their oaths to support.

This idea was strongly urged by the pro-slavery people just before the Civil War, in support of the Dred Scott decision, but, as is well known, it was attacked by President Lincoln in his first Inaugural as utterly without basis.

"The candid citizen," Lincoln pointed out, "must confess that if the policy of the Government upon vital questions affecting the whole people is to be irrevocably fixed by decisions of the Supreme Court, the instant they are made in ordinary litigation between parties in personal actions, the people will have ceased to be their own rulers, having to that extent practically resigned their Government into the hands of that eminent tribunal. Nor is there in this any assault

upon the Court or the Judges. It is a duty from which they may not shrink to decide cases properly brought before them, and it is no fault of theirs if others seek to turn their decisions to political purposes."

In short, while the Court can, and must, decide *cases* according to its own independent view of the Constitution, it does not in so doing decide *questions*.

For that matter, the Court has never regarded its own past interpretations of the Constitution as binding *itself*. These it has abandoned by one device or another many, *many* times. Why, then, should such interpretations be considered to be so much more binding on the national legislative power?

Let us, therefore, discard a theory which not only Lincoln, but Jefferson, Jackson, Theodore Roosevelt, and all the principal historians of the Constitution have treated as spurious; and doing so, where do we arrive?

We arrive at clear recognition that the national legislative body, Congress and the President, are vested not only with the power but with the duty to read the Constitution for themselves. To be sure, they are entitled to consult the opinions of the Court for such light as they may shed on particular questions of constitutional power. And indeed they should do so, since the Court has had valuable experience in these matters. At the same time, Congress is neither required nor entitled to abdicate its own independent judgment on the plea that the views of the *Court* are the authentic Constitution.

I contend, accordingly, that the President was *well* within his rights when he asked Congress to pass the Guffey Coal Bill despite "reasonable doubts" as to its constitutionality, although he would possibly have done better to have said "reasonable doubts" as to its *unconstitutionality*.

There can certainly be no sound objection to Congress's passing legislation which may enable the Court to clarify previous decisions on important questions of constitutional power. The fact is that constitutional doubts can be raised with respect to almost any legislation of broad scope. But I go further, and contend that there can be no sound objection to Congress's passing legislation with a view to enabling the electorate to indicate its preference as between the Court's view of the Constitution and Congress's view, when the two conflict. If, as some one has objected, this "puts the Court on the spot", yet it puts *Congress* on the spot *too*.

In short, the above view of the constitutional duty of Congress brings both the Court's and Congress's interpretations of the Constitution to the test of public opinion and so leaves the question of their *final* character to be determined by what Madison called "the will of the Nation."

To my mind, in "a government of the people, by the people, and for the people," that is how it ought to be determined.

Excessive Speculation

THE REGULATION OF EXCHANGES

By JAMES M. LANDIS, *Chairman, Securities and Exchange Commission.*

At the National Alumni Association Meeting of Princeton University, Nassau Hall, Princeton, New Jersey, February 22, 1936.

IN this familiar setting, where memories of the past cannot fail but come crowding in, time tends not so much to turn itself backwards but rather to halt for the moment to enable one to survey something of the road that we have travelled. So few opportunities apart from those that university life itself affords, exist for thought rather than action. To go back and seek meaning and purpose in the things that are done under the ever-pressing need for action, is, of course, the function of the universities. But we in the outside world do it only when some sharp disappointment, some unlooked-for failure, casts into question the whole direction of past effort. Otherwise Emerson's maxim that every man is as lazy as he dare be, holds true.

Some years ago saw such a happening in our national life. The normal course of American life, rudely dislocated by the War, seemed to my generation as it came to manhood to have re-knit itself. Political striving appeared to have become merely the eternal struggle between the ins and the outs, offering little challenge because it seemed to hold no issues. But as we view it now, we recognize the falseness of its calm. Even then, however, the shock of 1929 seemed but a passing phase, a momentary listing that our heavy keel would soon correct. But it continued, so that slowly thought as to our national well-being became the order of the day.

It is, perhaps, worth remembering the new vocabulary of the early thirties. Those to whom economics had always been not merely a dismal but dreary science, eagerly searched for the meaning of such concepts as "deflation," "trade balances," "downward spirals" and the like. And contrasting with the downward curve of business activity and employment, an upward curve in the demand for knowledge of the economics of our civilization was clearly discernible. We dared no longer be lazy in our thinking.

It is natural under circumstances such as these, when the normal forces fail to rally, to turn toward government for aid, and to make as our major demand the correction of what seemed an abnormal and too frightening condition. Nor under such circumstances are we inclined to insist that government exercise its traditional restraints. But with that call for recovery comes also sober determination to restrain and to prevent a repetition of what has taken place. Both challenges to government are intense, and both must be met.

The philosophically minded will have no difficulty in drawing a parallel between the Socratic doctrine of "know thyself" and the maxim that must guide a democratic government. Wherever authority is self-imposed the need for knowledge is obvious. If it be our ideal that as a nation we can by democratic means control our destinies, then to know ourselves as a nation would seem the first law of government.

In practical operation on the major issues of the past, government generally seemed responsive to the larger popu-

lar demands. Railroad regulation, anti-trust regulation, supervision of trade practices, and the like, were the result of a wide national insistence that measures of this type be enacted. As the public mind grew to recognize new types of fraud or to condemn practices seen to be unfair, it demanded their elimination. Government thus replied with its thou-shalt-nots. Yet analysis of most of this type of governmental action in terms of the democratic ideal will show that only a simple expression of national will was needed to bring into being the scheme of administrative control. That expression called for the elimination of a specific and definable cause of conduct or practice. After the recording of that expression through the ballot, the first step was to evolve a legislative formula which would define the type of practice sought to be condemned. Then an administrative scheme had to be created to translate into action the statutory formula, faulty or inadequate though it might have been in the first instance. Successive amendments in the light of this experience followed. Thus, unreasonable railroad rates were forbidden, rebates made illegal, certain combinations of business activity banned, utility rates limited upon the basis of a fair return, and innumerable other activities brought within the expanding social conceptions of right and wrong. The details of legislation and administration were difficult, but the general pattern and the method of seeking to control human conduct followed familiar and traditional lines.

For the problems of 1933, however, these familiar methods of governmental action were only partly adequate. True, a backward glance over the past few years developed certain new standards of right and wrong, and the public asked to have these transferred from the field of ethics into law. Something was disclosed as to the inadequacy of the states to cope with the violation of recognized rules of conduct with the result that a coordinate authority over these violations was given to the federal government. Insofar as legislation moved along these lines, no fundamentally new techniques were needed and only the familiar problems were presented to legislator and administrator. Typical of these, for example, is such legislation as the expansion of federal control over interstate crime, interstate bus regulations, holding company regulation, and the expansion of control over radio and the telephone.

The greater and newer problems of 1933, however, concerned not so much the policing of conduct, but involved an effort to correct certain tendencies in the development of our institutions—tendencies which were so perverse in their implications as to threaten the health of the whole body economic. Instead of seeking merely to control specific and definable types of conduct, the effort of government was partly to affect rational ways of life. To some degree these problems could be handled in the traditional method of prohibiting undesirable practices by statute and evolving administrative mechanisms to make these prohibitions effective. But the greater task lay in evolving ways and means to effect the springs of action, the underlying ways of life, in the hope thereby of evolving a better harmony between the operations of these institutions and the goal of restoring sound economy. And that task has evoked a new challenge to our faith in the democratic ideal.

Probably nowhere is the difference between these two types of governmental technique more clearly shown than in the recent legislation concerning private finance. National control over the issuance of new securities might have been effected in several ways. The federal government might have been charged with the duty of enforcing certain basic standards with reference to all new securities, such, for example, as limiting the cost of distribution, insistence upon appropriate amortization provisions, requirements for adequate and indestructible voting power, independent and supervised valuation of property for which stock is issued, or control over the contents of trust indentures, to mention only a few of the possibilities. Or even broader supervision of the investment merit of the security might have been conferred upon the federal government or power to gauge from a broad national standpoint the desirability of giving to a particular industry a share of the national capital available for investment. In that way, government might have been charged with the responsibility not only of assuming to guarantee such issues as it permitted to be sold to the public, but of assuming to dictate what channels would be open to private investment.

The method adopted in the Securities Act of 1933, however, was utterly different. It, of course, proscribed fraud, but it did not seek to thrust any responsibility upon government to earmark the good, the bad and the indifferent. Instead it placed upon government the duty to secure a measure of disclosure in the hope than an informed public would have both the ability and independence to guide the direction of its national savings. It did not strike at the inalienable right of the private investor to make a fool of himself. He was still free to choose, if he wanted them, speculative mining shares, participation in race tracks, and other speculative enterprises. The hope is, that in the light of knowledge, investment can most profitably be still a matter of private choice.

As an effort to preserve and make effective an economic institution by a practical application of the Socratian maxim "know thyself," the principle of legislation built along these lines deserves study. If ultimately it fails, too much that we hold vital in our national tradition fails. Some excuse for our past failure effectively to siphon our national savings into productive enterprise could be predicated upon an ignorance due to inability to get at the facts. But to fail in the light of knowledge may postpone until too remote a time the achievement of that independence of investment that we now seek.

For the success of such a scheme as this, mere sporadic exhibitions of national consciousness and desire are here wholly insufficient. Instead this consciousness must function continuously, cautiously and with discernment in order not to destroy the very institution that has been placed in its hands.

It was equally inevitable that one of the tasks of the new administration would revolve about the regulation of stock exchanges as an institution of our financial life. Two great problems were here involved. The first was the elimination of unfair methods of dealing. The second and greater problem was that of curbing excessive speculation.

The technique of dealing with the first problem, that of eliminating manipulative practices, followed traditional lines. Formulae to carry into effect the newer conceptions of good and bad were devised and mechanism to restrain and punish violations provided. True, new subsidiary techniques had and still have to be brought into existence to delimit the

allowable areas of conduct and to make infractions of the rules easy of detection. But from the standpoint of pure theory, the line of attack on this problem followed customary procedures.

It is in the second problem—that of curbing excessive speculation—that departures from the traditional lines of governmental action were called for. Obviously, the very concept of such a curb is one that is bound up with time and place and is measurable only in those terms. And obviously mere superficial analysis of the problem will illustrate that differentiation between types of conduct is not the solution, for here again a way of life is being affected and the measures of control must deal with deep springs of human action.

The means granted by the Exchange Act to cope with the recurrence of that danger are worth illustrating. In the first place, it is obvious that the outlawing of manipulative practices has its reaction on undue speculation because, frequently, the purpose of these practices is to induce the very type of speculation that feeds the manipulator at the expense of the public. A second devise consists in a grant of power to government to make something in the nature of a flank attack upon speculation through its control over the quantity and nature of credit that may be used to purchase or carry securities. This control over speculative credit extends not only to the regulation of margins or permissible loan values on securities, but also to the restriction of the sources from which credit for these purposes may flow. Such a device, of course, as a check upon excessive speculation will operate effectively only where that speculation springs from the ability freely to employ such funds.

Other partial means exist which are available to effect certain aspects of this problem. Such, for example, is the power to restrict or indeed to prohibit floor trading and specialist trading for his own account. These, however, can only affect such excessive speculation as may arise from these causes.

That undue speculation has sources for its origin more widespread and more persuasive than these is undoubted. It may and frequently does spring from cupidity subtly disguised under the cloak of investment. To strip that disguise and to bring home to those who participate in it the real character of this type of buying and selling as mere crass speculation that has no regard to values is yet another task. To accomplish it, bases for a theory of investment values as contrasted with a theory of speculation must be continuously set forth. To that end the legislation granted a third and most important means for struggling with this problem of excessive speculation. This is the machinery and duty of making available to the public illuminating and somewhat continuing information to which it may refer in an effort to reach a judgment on values as to the securities that are traded upon exchanges. I speak designedly of this as a method for dealing with excessive speculation, for, obviously, it is the very availability of such information that distinguishes an investment market from one in which prices have no relation to profits, one that reflects only the hope of passing on to another at a higher price what may originally have been dearly bought.

This third method, which rests avowedly upon the democratic ideal, has all the strength and weakness of that ideal. Like that ideal it bases itself upon a hope—the hope that through the dissemination of knowledge some ability to buy and sell with reference to values will tend to keep a nation from wanting to drink the heady wine of excessive speculation. But its weakness is that very faith. Men whose experience, unlike mine, has been that of yearly and intimate contact with the downtown board-room regard it as little more than visionary. Their cynicism in the purchase of securities is so deeply rooted that this effort to try to induce people to buy and sell on the basis of balance sheet rather than ticker tape seems worse than futile.

Some tinge of that cynicism tends necessarily to touch those who are close to the scene. The often still prevalent conduct of customers' men to encourage activity by irresponsible talk, sometimes merely for the sake of activity, has to be met by the effort to educate their customers away from such insinuations to speculate. One sees with concern the efforts of traders to out-guess events, like Court decisions and the increasing tendency subtly generated to induce people to pour their savings into the market with the same heedlessness as before. Still too prevalent, as our monthly reports show, is the tendency of officers and directors to toy with the stock of their corporations at the expense of their true responsibility of functioning as executives.

These things are the ways of life that we condemned in the early thirties. But to harry them out of existence by legislative fiat is impossible. Our only mechanism is to induce change by inculcating the wish for change and by affording the means of knowledge to effectuate that change.

It may be that we shall fail, and the prophesy of my cynical friend of the board room that we will continue to be a nation of gamblers may come true. But what we can do is to afford the public mind the opportunity to reject that way of life, and upon the basis of such a rejection to remodel our financial institutions to make them responsive to the demands for investment rather than mere speculation.

The weakness of such a means of governmental control must be obvious to any one in university life. No teacher worthy of his salt has not been filled with pessimism over his own inability to portray a problem and the unwillingness of a class to indulge in the intellectual effort necessary to grasp it. The same pessimism is intrinsic to the government. But both carry on—the first in the blind faith that the increase of knowledge may somehow make for happiness—the second in its blind democratic faith that through knowledge realization of the Benthamite ideal will become more possible of achievement. True, both have their draughts of pessimism, but to neither can pessimism be more than a passing phase. Were we to admit it as more than such, the very essence of both institutions would be at an end.

The significance of a commonplace truth, such as this, increases proportionately as the efforts of government move away from police regulation to the task of fashioning our institutional life so that it will effectuate rather than destroy our simple demands for well-being. In such a field, not only does the challenge lie to devise instrumentalities of government, but in making them the means to understand and thereby to control the directions of national life. In meeting that challenge universities and government are, of course one—one not only in the direction of their effort but in their hypothesis of a faith—faith in the capability to know and through knowing to achieve. It is, of course, a faith that calls for expression in terms not of *dubito ergo sum* but in terms of *cogito ergo ero*.